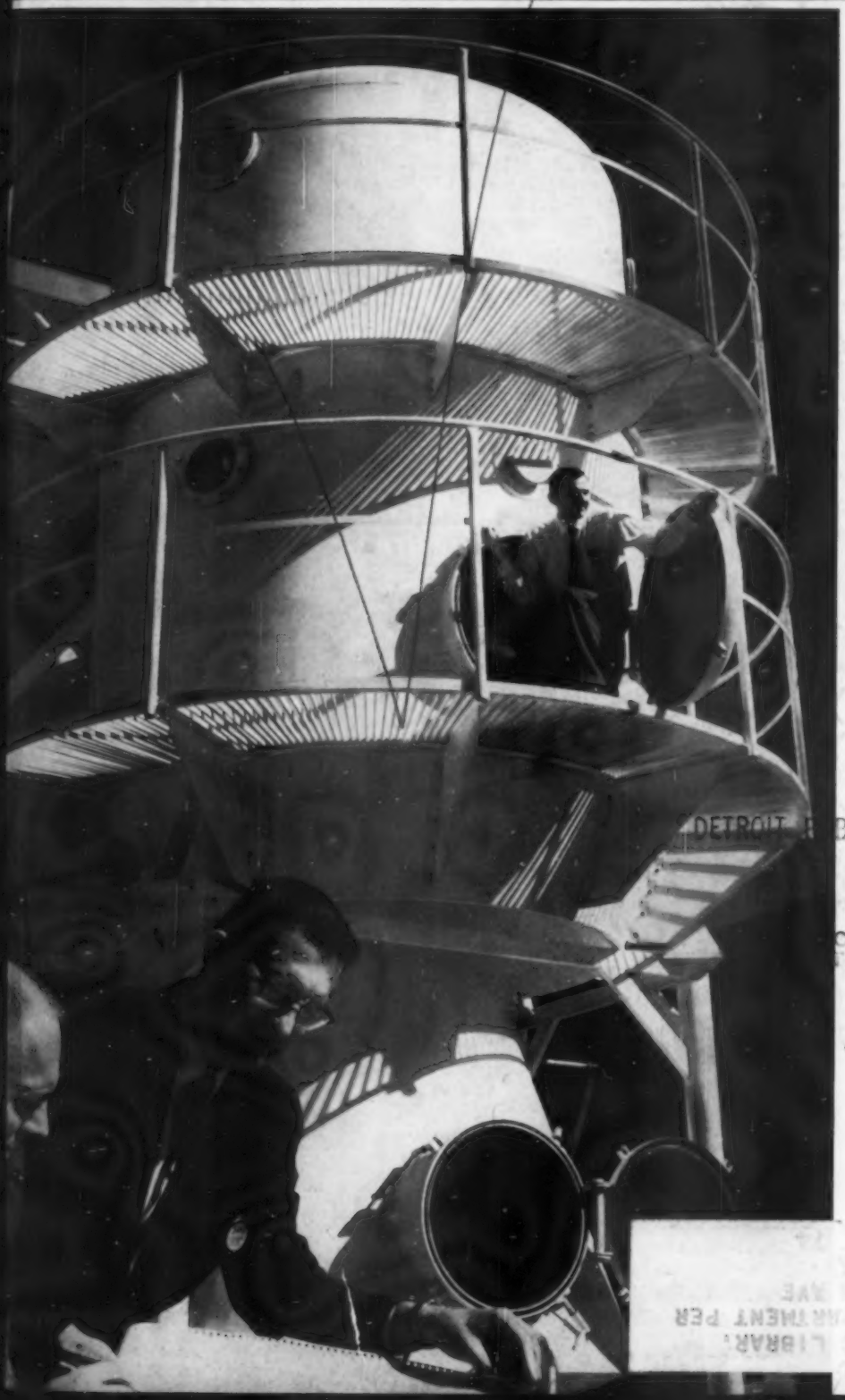
MARCH 6, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY



V.8 #10

Dyna-Soar Will Get Solid-fuel 3rd Stage

- JFK Weighs 'Shift' in Arms
- Cleaners Bare Missile Flaws
- New Edition— M/R Astrolog

Convair's Three-Man Space Station Model

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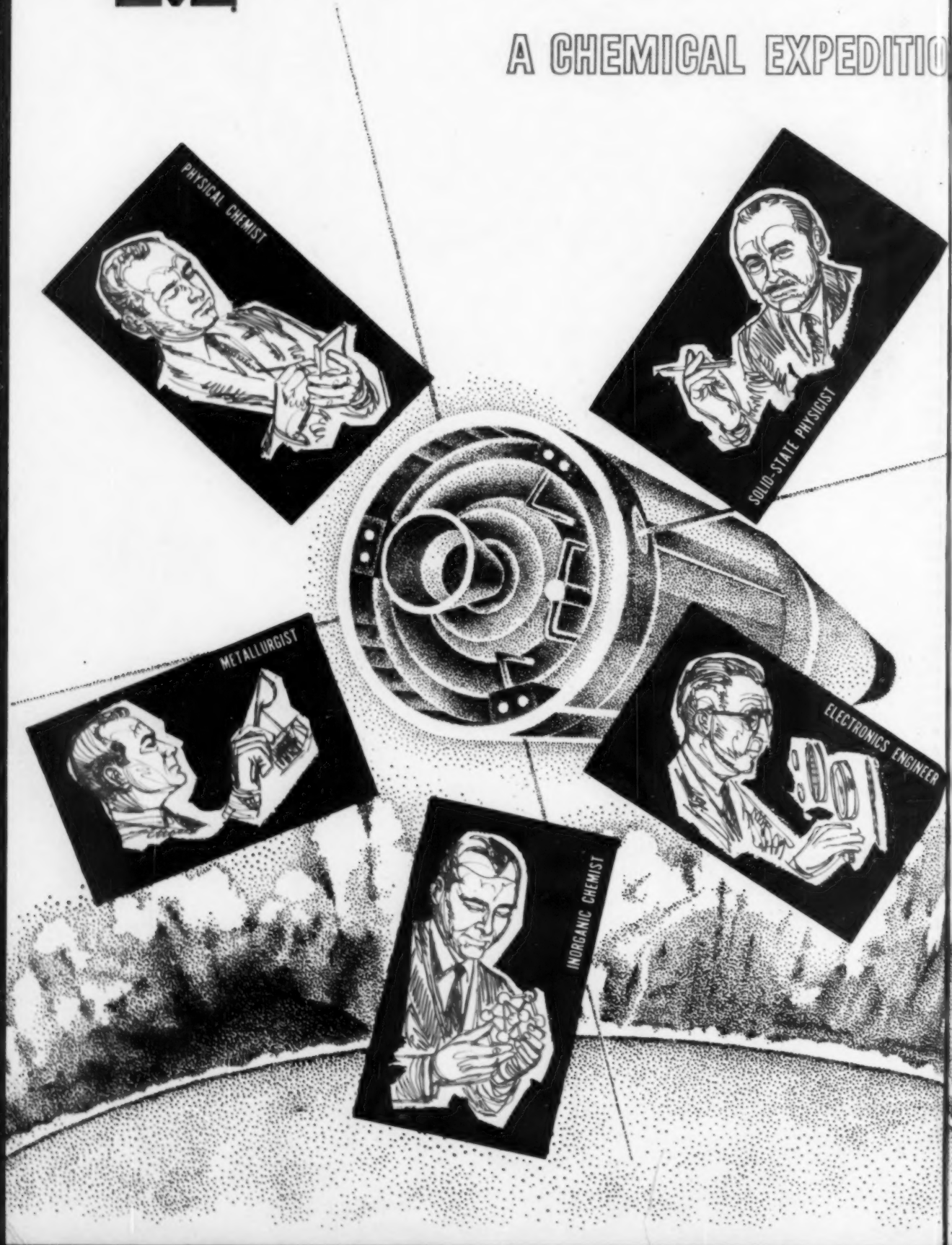
Space-Age Project "ELECTRON"

A CHEMICAL EXPEDITIO..r



..ranging the fields of ultra-pure metals and "intermetallics"...finds new chemical routes to materials for advanced electronics

Monsanto research in the chemistry of silicon, phosphorus, ultra-fine metals and oxides, and "super-pure" elements and compounds has found promising leads to improve semiconductors. These materials—developed by the synergistic collaboration of solid-state physicists, inorganic chemists, and physical chemists—forecast improved performance of transistors, photoconductors, thermoelectric generators and coolers, solar batteries, rectifiers, thermistors and other electronic applications that depend upon the tractability and mobility of electrons moving through special composition solids.

Monsanto researchers, from a firm base in the commercial production of semiconductor silicon (under Siemens-Westinghouse license), have found a number of intriguing leads to new and improved semiconductor materials suitable for transistors, rectifiers, diodes, thermoelectric coolers and generators, and Hall-effect devices.

Since the middle 50's—the burgeoning uses of transistors, diodes, rectifiers, as well as thermoelectric, photoelectric, and servo devices, have kept chemists on a dogged search for substances with a given quantum of mobile electrons that would behave predictably. To the "armchair chemist" the semiconductor problem might look deceptively simple: check out a relatively few elements and compounds, purify them highly, dope them in the order of 1:10,000,000 with an element from another periodic group to provide the proper *n* or *p type* conductance; and grow into crystals.

A minimum of experimentation, however, would quickly establish that the chemistry of preparing the super-pure materials and uniformly doping them to produce n-type and p-type semiconductors is one of the most intricate problems that inorganic and physical chemists have ever tried to solve. Not the least of the problem is that no reliable method has been developed to predict the energy gap; all possible combinations and proportions of candidate elements have to be prepared and the energy gap determined empirically!

In attacking this whole problem of semiconductor materials for advanced electronics, Monsanto research is focused on the following four areas of study:

1. PURITY IMPROVEMENT...
of "III-V" semiconductor compounds by at least one or two orders of magnitude over best purity yet available; and, concomitantly, studies of new techniques for converting these high-purity compounds into single crystals. When completed, a variety of new and improved electronic devices can be developed with these high-purity materials.

2. "SPOT" SYNTHESIS AND SCREENING...
of candidates in numerous classes of compounds for organic semiconductors—compounds where structural concepts point to the compounds' ability to shift electrons. (In organic semiconductors, too, uniformity and purity are vitally important.)

3. NOVEL CHEMICAL PROCESSES...
are under intense study for the preparation of compounds of group "II-VI" type semiconductors.

4. NEW INORGANIC SEMICONDUCTORS...
i.e. gallium and indium arsenides are now available for research and development. Doping of gallium arsenide is in progress.

A major purpose of this semiconductor chemistry research is to find materials with greater reliability over a wider temperature range, the ability to function at high temperatures, and variously with improved electrical, photoelectric, thermoelectric, magnetic, and photoconductance properties. By intensifying—chemically—the electronic property sought, improved devices based on these properties will become feasible. In collaboration with electronics manufacturers, the materials now on the horizon will serve in telemetry, automation monitoring devices, guidance computers, ignition systems, and communications equipment. These materials will also open the door more widely for increasing the efficiency of thermoelectric power generation, thermocooling devices, and photoelectric power generation. Promising leads are under study in "III-V" semiconductors of indium, gallium, and boron phosphides;* in new "II-VI" compounds and others.

(Please turn page.)

**F. V. Williams and R. A. Ruehrwein, J. Am. Chem. Soc., 82, 1330-2 (1960); D. E. Hill and B. D. Stone, Physical Review Letters, 4, 282 (1960).*

THE BROADENING SPAN OF CHEMISTRY FOR ELECTRONICS

Monsanto researchers have already produced a variety of unique materials chemically tailored for the particular needs of electronic engineers. These materials range from liquid dielectric coolants for "packaged" units to singularly pure, reliable-performance large crystals of meticulously doped silicon. Many more, however, like the following, are in various stages of development:

"III-V" INTERMETALLICS...
prepared by Monsanto Research include polycrystalline indium arsenide (now used in Hall-effect devices such as watt-meters) and both single-crystal and polycrystalline gallium arsenide for tunnel, parametric, switching, and Zener diodes.

DISPERSION-STRENGTHENED NICKEL AND COPPER METAL AND METAL POWDERS...
are under study for corrosion-resistant electrodes, electrical contacts, and as high-strength, high-temperature core leads for electronic tubes and apparatus.

HIGH-STRENGTH CERAMIC ENVELOPES...
for vacuum tubes using specially developed fine mixed metallic oxides.

SEMICONDUCTORS AND SPECIAL COMPOUNDS FOR ELECTRONICS...

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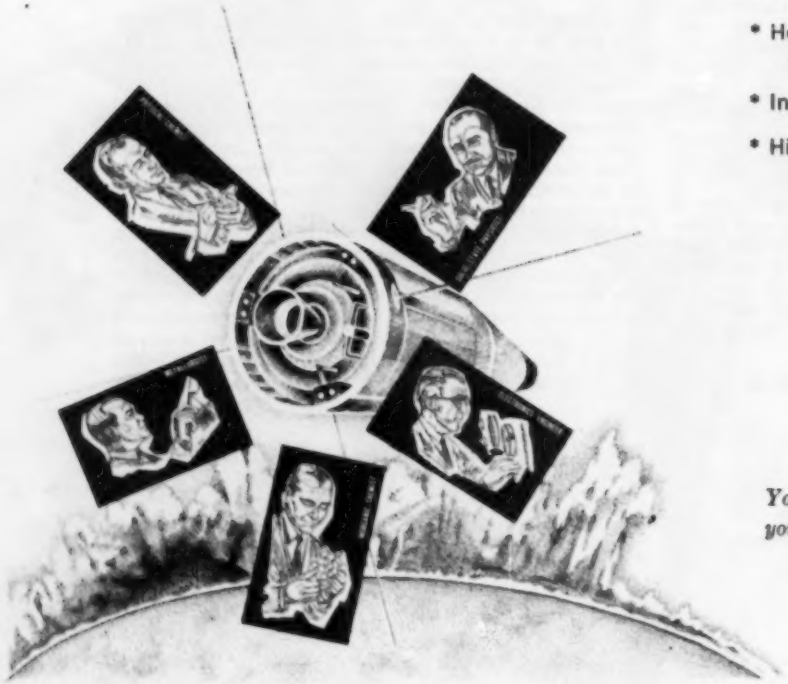

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, No. 10 March 6, 1961

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THE COVER

Convair's MARS (Manned Astronautical Research Station) is full-scale working model of three-man space station. William Kudenov (left) is project leader; Freeman D'Vincent (center) designed the station.

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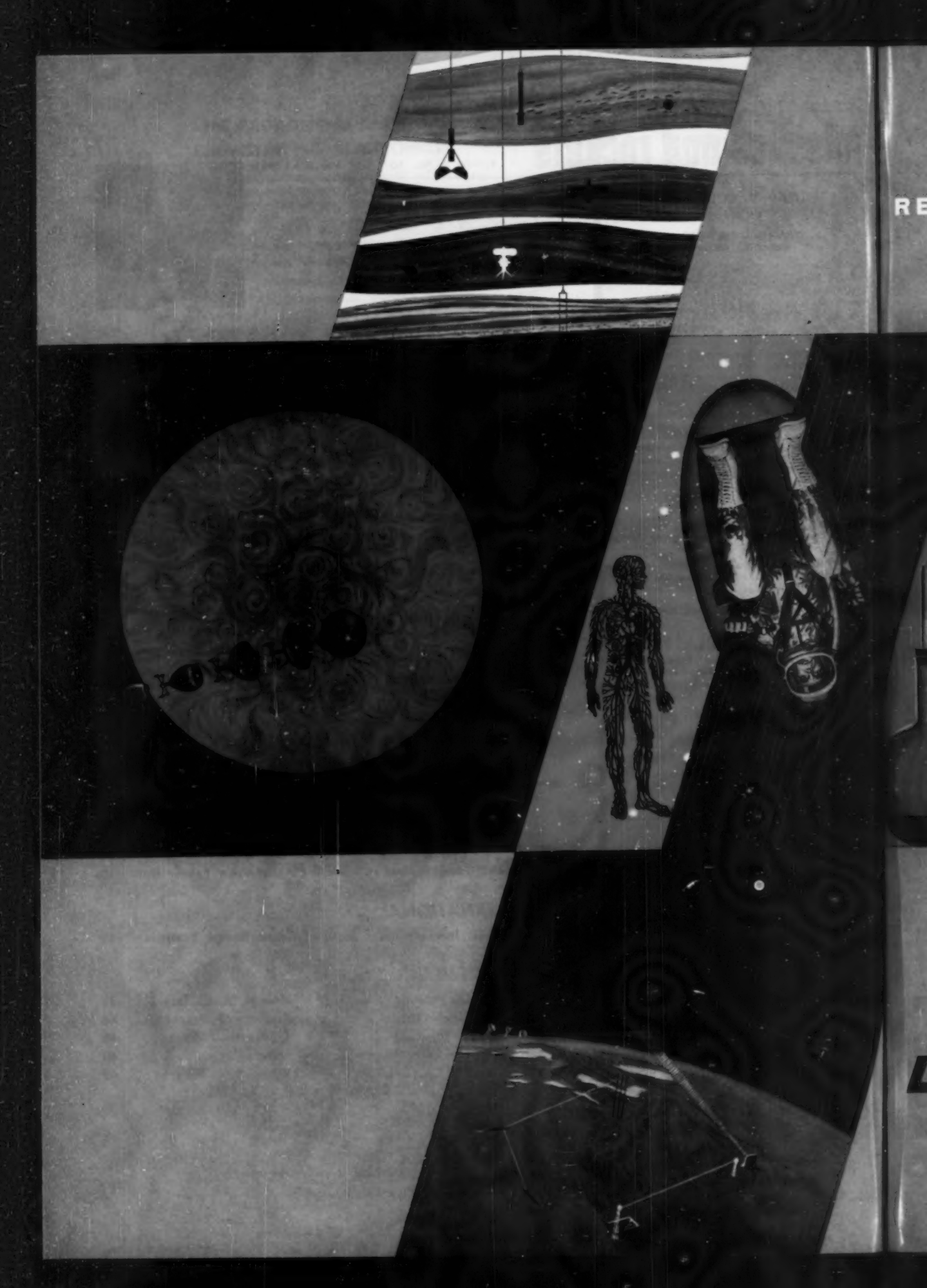

RESEARCH AND DEVELOPMENT AT LOCKHEED

...is setting the pace in space for years ahead

Lockheed Missiles and Space Division's progress transcends even that of an era marked by phenomenal scientific growth. To an important degree, the Division's research and development activities are considered to be the basis of its success.

As systems manager for the Navy POLARIS Missile and the Air Force AGENA Satellite in the DISCOVERER and MIDAS programs, the Division is engaged in extensive research in many diverse engineering and scientific fields. Some highlights of current research and development activities include: Operations research and preliminary design; nuclear and space physics; physical electronics; chemistry; materials; mathematics; engineering mechanics; electronic communications and instrumentation; and computer research and development.

Research is a concept which holds many different meanings to those concerned with science and technology. At Lockheed, a distinction is made between the *nature* of the work and its *objectives*. Consequently, such terms as basic research, applied research, systems or operations analysis, engineering and development are used. A given individual might find that his personal inclination often leads him quite naturally from one type of research to another. Recognition of this desire is reflected in the scope of work conducted in the Research Branch at Lockheed Missiles and Space Division. Principal research activities are: Pure and applied research; advanced design; engineering analysis; electronic prototype development; and machine computation.

Organization is determined by the *technical field* rather than by the *type of research*. For example, a structural dynamicist, as a member of the Structures Department, may, on one occasion, work on future space vehicle configurations, at another time be associated with current projects such as the POLARIS or Satellite programs, or he may be engaged in basic research at the research laboratory. In each case, the individual has the opportunity to maintain as much or as little contact as he wishes with others in his field of interest.

Important staff positions at Lockheed's Research and Development Branch in Palo Alto are available. Those scientists and engineers with experience related to the above areas are invited to write to: Research and Development Staff, Dept. M-25A, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance is required.

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The Countdown

WASHINGTON

Morticians Measure ANP

Hopes for obtaining a nuclear-powered, missile-packing bomber are now all but dead. Top officials are conceding the ANP (air nuclear power) program appears to be leading nowhere, although about $1 billion has been spent on R&D. Says one: "You might say ANP is barely twitching."

Military Space R&D Still 'Safe'

Continued high spending on military space R&D appears not to be in jeopardy in the "New Look" defense posture being weighed by the Kennedy Administration (see p. 14). The Air Force feels there will be heavy emphasis on offensive and defensive space systems, even though it has failed so far to sell the Administration on the merits of building a strategic missile counter-force.

More Megatonnage?

Hot military issue underlying the East-West nuclear test ban talks that are to resume shortly is whether the United States will be permitted to increase the yield of *Polaris* and *Minuteman* warheads. Physicists believe megatonnage can be more than doubled, but not without more testing. This would be done underground to eliminate fallout—as the Soviets are suspected of doing already.

Status of Soviet Air Defense

Highly authoritative U.S. sources have told Congress that the Soviets appear to be on a par with the United States in the development of rocket air defenses. The Russians are reported to be deploying their second-generation surface-to-air missiles, as is the United States. The second generation *Nike-Hercules* is capable of destroying Mach 3 targets at 100,000 feet.

New Hunter-Killer Aircraft?

Some Air Force strategists are pushing for development of new hunter-killer aircraft for use against Soviet missiles in successive strikes in a nuclear war. The planes might carry up to 40 missiles with 1-kiloton warheads.

NASA Reveals Pricetags

Cost of three NASA space vehicles is now put at: *Scout*—$17 million (for development and first nine vehicles), $935,000 per operational launch; *Centaur*—$170-180 million (for development and first 10 vehicles), $7.5 million per operational launch; *Saturn C-1*—$1 billion (for development and first 10 vehicles), $20 million per operational launch.

Echo's Progress

Program for follow-on *Echo* passive communications satellites includes: *Echo II*—to be launched into an 800-mile polar orbit in 1962; the launching of three rebound spheres to a 17,000-mile orbit in late 1962, and simultaneous orbiting of six satellites a year later with a *Centaur* vehicle.

INDUSTRY

Defense Budget Reform Coming

A broad reform in defense budgeting procedures is under study in the Pentagon. Its aim: To provide top military planners with precise and comprehensive estimates of the total cost of major weapons and programs. This will mean that the fiscal managers of weapons projects will have to come up with the needed data.

Nose Cone Stretchout Hits GE-MSVD

Payroll cutting is underway at GE's Missile and Space Vehicle Department because of stretchouts in the *Sky Bolt* and *Titan* Mark VI nose cone programs. Company officials estimate some 600 employees—about 8% of the department—must be transferred to other divisions or laid off.

Naish Splits from GD

"Policy differences" with the management in New York are said to have led to the resignation of J. V. Naish as president of Convair, a post he had held since 1958. Naish also was a senior vice president of General Dynamics. Named acting president of Convair was C. Rhoades MacBride, who is also GD executive vice president.

Douglas-Nesco Sign Research Pact

The National Engineering Science Co. of Pasadena, Calif., will perform advanced scientific research for Douglas Aircraft under a new agreement between the two firms. Work will supplement Douglas advanced research programs. Douglas will provide Nesco with engineering and production support facilities.

Prospector Contracts Due Soon

NASA is understood to be prepairing to let study contracts in the near future for its *Prospector* mooncraft. The *Prospector* will be designed to land on the moon and roam its dusty surface by remote control. Time for take-off: 1965-1970.

INTERNATIONAL

Britain's Defense Budget

The British defense budget for FY '62 allots $1.5 billion to the Royal Air Force, $1.4 billion to the Army and $1.2 billion to the Royal Navy. Major missile armament continues to be the *Blue Steel, Honest John, Thunderbird* and *Seaslug*. ASW is to be beefed up with a new helicopter-dropped torpedo.

New Space Combine

France's SEREB and Britain's Hawker-Siddeley group are planning to move quickly into the commercial communications satellite field. The new combine is reported aiming to get a workable system in orbit by 1965, perhaps sooner, to compete with U.S. companies.

Sputnik VII Dies

The 7-ton *Sputnik VII* launched Feb. 4 burned up in the atmosphere on Feb. 26. One portion of *Sputnik VIII* which launched the Russian Venus probe Feb. 12, decayed on Feb. 25. NASA's Goddard Space Flight Center reports that fragments from both *Sputniks* are still in orbit.

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The Missile/Space Week

Minuteman Site Award

The Army Corps of Engineers has awarded a $61,773,644 fixed-price incentive-type contract to the joint venture of George A. Fuller Co. and Del E. Webb Construction Co. for 150 operational *Minuteman* facilities at Malmstrom AFB, Mont.

The contract was delayed for some time because the first group of bids received ranged from 50 to 100% higher than the Army's original estimate of $50 million.

The bids were knocked out and the Army added $12 million to estimates for contractor contingencies such as remote sites, terrain, and road conditions.

Brig. Gen. A. C. Welling, Commanding General of the Corps of Engineers Ballistic Missile Construction Office, said work will start by mid-March and is to be completed in 20 months. Date of the contract for the second *Minuteman* Site at Ellsworth AFB has not been disclosed.

NASA Spurs Rover

NASA is reviewing its nuclear propulsion program so it can "proceed as rapidly as the technology will allow."

Deputy Administrator Hugh L. Dryden told the House Space Committee last week, "We are evaluating the needs of the program to insure that all necessary resources are provided."

The decision will mean increased funding for Project *Rover* in FY 1962. It also may result in a reversal of former Administrator T. Keith Glennan's stretchout of the *Rover* flight program. With his resignation last December, Glennan announced a delay of the target date for the first flight from 1965 to the 1966-7 period.

The Air Force is also maintaining its interest in exploiting the nuclear rocket for military application as an upper stage, as an inspace propulsion device and possibly as a single-stage launch system. ARDC has contracted a $400,000 nuclear rocket study.

S-45 Waits in Wings

A backup *Juno II* vehicle is available for another attempt at launching an *S-45* ionosphere beacon satellite, but no decision will be made until after the *S-15* is launched, probably this month.

Just two vehicles now remain in the *Juno II* program. If the *S-15* cosmic ray satellite launching succeeds, the second will be used for a new try with *S-45*. If that fails, a decision will have to be made between the two for the last vehicle.

The first *S-45* was launched Feb. 24. NASA said all available evidence showed it did not achieve orbit. A malfunction shortly after booster separation was followed by loss of radio transmission. No tracking station acquired data that would indicate orbit.

Advanced Polaris Scores

First sea launching of the advanced *Polaris* missile showed promising results in the Navy's program to bring the one-ton heavier model to combat readiness late this year.

Carrying only a rudimentary steering system for the test, the *A2* flew its entire range of 1500 nautical miles. The improved *Polaris* employs a more powerful solid fuel and has a greater fuel capacity than those now on station. Its 30-foot length is two feet longer than the operational model.

The *A2* has already scored three successes in four firings from stable pads at Cape Canaveral.

First Atlas E Success

The *Atlas E* finally got started on its test program with last week's successful launch—the first success in four tries.

The *E*—first series with inertial guidance—will be the operational model for "coffin" launch sites.

After three failures, trouble was finally traced to a hydraulic control system. Improvement of the basic system—which had operated successfully throughout the program—apparently introduced some new bugs of its own.

The *Atlas F* now in the works is a streamlined version of *E* without instrumentation, for silo launch. Convair has also proposed a *G* version to the Air Force. This would be a radically different *Atlas* with improvements roughly comparable to those between *Titan I* and *Titan II*.

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For specific details write:
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Award next month . . . .

Dyna-Soar to Get Solid Third Stage

Boeing to order some 100 units similar to second stage of Minuteman; glass seen likely choice for lightweight case material

LOS ANGELES—A solid-fueled third stage will be added to the *Titan II* booster for *Dyna-Soar*.

MISSILES AND ROCKETS has learned that Boeing Airplane Co. will award a contract next month for the new stage—described as a "foreshortened *Minuteman* second stage" able to generate about 60,000 lbs. thrust. The stage will be used to kick the *Dyna-Soar* glider to orbital velocity.

Approximately 100 cases are understood to be involved in the overall contract. Among the bidders are Aerojet-General Corp., Thiokol Chemical Corp., Grand Central Rocket Co., Hercules Powder Co., and the Rocketdyne Division of North Amerian Aviation Inc.

The disclosure came as:

–Lt. Gen. Bernard A. Schriever was reported ready to ask for a $100-million increase in FY '62 funding for *Dyna-Soar* to bring the total to $170 million. It would be used to chop 19 months from the development program and launch the first manned flight of the system by mid-1963.

–The Air Force said the first flight test of the glider aboard a *Titan II* (see artist's conception at right) would take place "within a year."

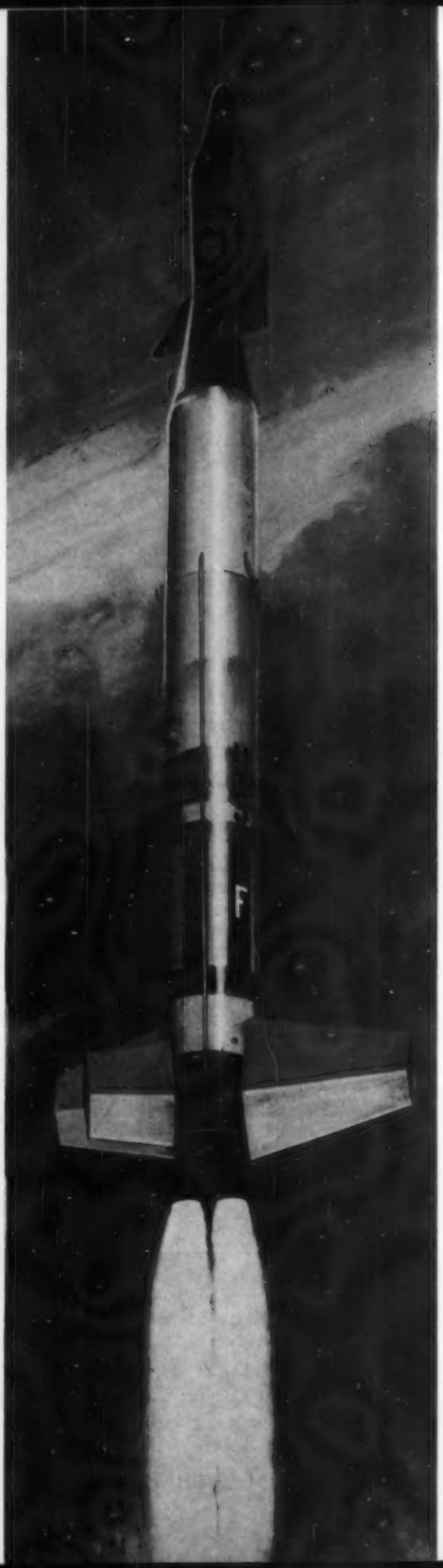
There was some thought that the switch from *Titan I* to *Titan II* (M/R, Jan. 30, p. 11) would eliminate the requirement for a solid third stage. Even if this does prove to be true, it is understood the unit will be retained anyway for use as an escape system similar to that on NASA's *Mercury* capsule. Hence nozzles will be designed for optimum operation at sea level—rather than at altitude.

Nozzles will be movable plus or minus ten degrees in one axis, but it has not been determined whether North American's Autonetics nozzle control unit will be used, as it is on *Minuteman*. The main requirement is that the motor be the lightest solid rocket possible.

Boeing is choosing light weight over optimum theoretical performance for the subsystem, with extreme emphasis on reliability—particularly for the escape application.

The escape mode would permit the pilot to trigger the

(Continued on Page 43)



Big Solids—Booster Breakthrough?

Solids specialists argue that segmenting is answer to gap—and will save funds

by Jay Holmes

"Unless we are able to make a scientific breakthrough, we have to realize that we are in a . . . secondary position on boosters. . . . The Soviet Union has been ahead, and it is going to be a major task to surpass them."—John F. Kennedy, Feb. 15, 1961.

MANY EXPERTS in government and industry are convinced that a big booster breakthrough already has taken place—all that is needed is a relatively modest sum of money to exploit it.

This "overlooked" breakthrough is in solid propulsion—a field in which the United States is believed far ahead of Russia and the rest of the world.

The breakthrough took place as far as they are concerned in February, 1953, 4½ years before *Sputnik*, when a small group of engineers from the U.S. Army, General Electric Co. and Thiokol Chemical Corp. flew the world's first case-bonded solid rocket —*Hermes RVA-10*—to a height of 190,000 ft. It was based in part on earlier research by Jet Propulsion Laboratory and Aerojet-General Corp.

Since then, scientists familiar with solid propellants have always claimed the sky was the limit for range and size, with minimum cost and complexity. But solids have never overcome the early lead of Liquid Rocket development.

The record shows that every major solid-propulsion program has met its objectives, on about the schedule promised, and within a figure close to the promised cost.

Within the last few months, *Polaris* has gone on station, *Minuteman* has flown all three stages perfectly on its first flight test, *Scout* has orbited a satellite on its fourth flight, and *Nike-Zeus* has passed preliminary tests.

• **$60 million price tag**—Solids specialists believe the time is ripe now to begin developing a large solid rocket, with total impulse of about 180 million pound-seconds, which would have two functions:

–It would provide a backup for the liquid-propelled *Saturn*, a giant basket in which America has placed all its eggs for the booster race with Russia over the next four or five years.

–It would compete directly with the single-chamber, liquid-propelled F-1 for the right to provide the basic propulsion unit for the booster on the manned lunar mission.

The cost? Industry estimates vary, perhaps by the degree of "salesmanship," between $35 and $55 million to develop the engine over a period of roughly 30 months. Informed government officials are confident the cost could not exceed $60 million.

This figure compares with spending of $250 million this year alone for *Saturn*. It compares with more than $50 million spent to date on developing the F-1—with several years of work before development is complete.

CROSS-SECTION of grain of giant solid rocket, proposed by Thiokol, providing about 15,000,000 lbs. of thrust.

No one is suggesting that work on *Saturn* and F-1 be scrapped or curtailed. The solids people put their idea forward in the spirit that the Kennedy administration is receptive to proposals that America do more to assure that we catch up in boosters at the earliest possible moment.

The cost of beginning the program in Fiscal Year 1962 is estimated at $10 million. Carrying it to completion would probably require $20-25 million the following year and something less the year after.

(Continued on Page 43)

Experts Agree on Feasibility

SCIENTISTS FROM INDUSTRY generally agree that a big solid rocket can be developed cheaply and in a short time. Some typical comments:

Dr. Harold W. Ritchey, president of the American Rocket Society and a vice president of Thiokol, has said it would be possible to fabricate a 3-million-lb.-thrust solid in less than three years. "If we were in a hurry," he added, "we could have it in 18 months."

Dr. Ernest R. Roberts, assistant manager of the Aerojet-General Solid Rocket Plant, says no more feasibility proofs are needed. "*Polaris* and *Minuteman* have proven it, and the large segmented rockets we have fired—400,000 lbs. thrust—have proven the concept completely."

John Crowley, vice president, Grand Central Rocket Co., says the solid rocket is America's best hope to catch Russia in the booster race. "Unless we open our eyes," he declared, "we are going to be caught again as in 1957 with *Sputnik I* and in 1961 with Venus rocket."

Dr. David Altman, vice president of United Technology Corp., says America should "increase the versatility of our total arsenal of boosters by embarking on solid rocket programs, which will give greater economy and reliability and eliminate the thrust limitation."

Dr. Lyman G. Bonner, director of development, Explosives Department, Hercules Powder Co., says the principle of segmenting units weighing up to 150,000 lbs. removes the transportation limitation on solid rocket size and "there seem to be no inherent limitations."

Bonner said it is not clear there is incentive to build big segmented rockets today, because *Saturn* is well along in development. He added:

"I am sure, starting from scratch, a very large solid rocket could be developed and at less than the development cost of a corresponding liquid unit. We are not starting from scratch, however, since the . . . liquid units are in being or in the late stages of development."

McNamara Reported Favoring Army-Navy St

Recommendations to Kennedy may speed missile deployment, add limited war forces; base 'mess' debated

by James Baar

DEFENSE SECRETARY Robert McNamara's secret recommendations for strengthening the nation's military posture are understood to be generally based on the Army-Navy advocated strategy of "finite deterrence."

If accepted, McNamara's recommendations would mean:

–A speed-up in the deployment of big strategic missiles on land and sea, but not a large increase in the total number already planned under the Eisenhower Administration in its final months.

–A sizeable increase in the nation's limited war forces, particularly far more rapid modernization of the Army and possibly several more divisions.

McNamara sent his recommendations to the White House amid new calls from Congress for production of the *Nike-Zeus* anti-missile missile and sharp congressional criticism of the Air Force ICBM base construction program.

Rep. Harry R. Sheppard, chairman of the House Subcommittee on Military Construction Appropriations, bluntly called the considerably delayed base-building program "a mess." Previously secret testimony released by his subcommittee showed that base-building costs have exceeded original estimates by 50 to 100% in many cases.

In regard to *Zeus*, House Democratic Leader John W. McCormack personally took the floor to urge production "at the earliest possible moment." He added: "It is ready for initial production now."

"On the day the Army is able to emplace *Zeus* batteries in active, operational defense against incoming intermediate and intercontinental ballistic missiles, this nation will again stand in a dominant position in the world," McCormack said.

The next day Rep. Daniel Flood (D-Pa.), an outspoken member of the House Defense Appropriations Subcommittee, wrote a letter to President Kennedy urging the immediate production of *Zeus* (see page 18).

• **No such change**—Kennedy at a news conference last Wednesday made the first official disclosure of at least

How ICBM Bases Slip, and Spending Soars

All dollar quantities are in millions.

	LOCATION	ORIGINAL CWE	CURRENT CWE	FUNDS	NO. OF CON-TRACTS	MAJOR CON-TRACT NO.	CONTRACTOR	DATE OF AWARD	ORIG CONTR COMPL DATE	CURR CONTR COMPL DATE PR
ATLAS D	Vandenberg 65-1	Lompoc, Cal.	$ 9.0	$14.9	$14.8	12	5280	Frederickson-Kassler-Stolte Inc.	4 Jun 57	1 Sep 58	Mar 59
	Vandenberg 65-2	Lompoc, Cal.	8.9	10.5	10.6	12	6293	Utah-Hardeman-Manhattan	18 Jul 58	19 May 59	Aug 59
	Offutt	Omaha, Nebr.	24.0	31.3	28.6	19	5535	Malan Const. Co.	30 Mar 59	17 Apr 60	Aug 60
	Warren I	Cheyenne, Wyo.	25.7	26.7	26.7	16	5064	George A. Fuller Co.	22 Jul 58	19 Aug 59	Sep 59
	Warren II	Cheyenne, Wyo.	19.9	28.1	25.2	10	5490	Blount Bros. Const. Co.	11 Mar 59	1 Feb 60	Jul 60
			86.6	111.5	105.9						
	Warren III	Cheyenne, Wyo.	28.8	32.8	33.1	5	5914	Martin K. Eby Const. Co.	4 Dec 59	1 May 61	May 61
ATLAS E	Fairchild Launchers A, B, C	Spokane, Wash.					4816	Patti-MacDonald-Scott-Leavell	27 Apr 59	5 May 60	Aug 60
	Ops Bldgs A, B & C		25.8	40.8	34.6	38	4869	Henry George & Sons	19 Jun 59	6 Mar 60	Sep 60
	Sites D thru I						4897	Blaw-Knox Corp.	26 Jun 59	1 Aug 60	Nov 60
	Forbes Launchers A, B, C	Topeka, Kans.					3821	Independent Contrs. & Engrs.	5 May 59	1 Jun 60	Nov 60
	Ops Bldgs A, B & C		27.5	38.0	36.8	19	3874	Independent Contrs. & Engrs.	12 Jun 59	1 Jun 60	Jun 60
	Sites D thru I						3896	Blaw-Knox Corp.	29 Jun 59	1 Sep 60	Mar 61
			82.1	111.6	104.5						
	Schilling	Salina, Kans.	37.2	48.6	48.9		4281	Utah-Manhattan-Sundt	7 Mar 60	26 Jun 61	Jun 61
	Lincoln	Lincoln, Nebr.	37.4	44.7	44.7	22	6186	Western Contr. Corp.	15 Apr 60	16 Jul 61	Jul 61
ATLAS F	Altus	Altus, Okla.	38.8	40.8	41.5	23	5909	Morrison-Knudsen-Hardeman & Assoc.	27 Apr 60	16 Aug 61	Aug 61
	Dyess	Abilene, Tex.	36.9	37.3	40.4	24	5878	H. B. Zachry Co. & Brown & Root, Inc.	27 May 60	6 Sep 61	Sep 61
	Walker	Roswell, N. Mex.	42.2	41.8	40.8	24	2590	Macco-Raymond-Kaiser-Puget Sound	16 Jun 60	10 Nov 61	Nov 61
	Plattsburg	Plattsburgh, N.Y.	43.0	43.9	44.2	24	9522	Raymond-Macco-Kaiser-Puget Sound	14 Jun 60	27 Nov 61	Nov 61
			235.5	257.1	260.4						
TITAN I	Lowry I	Denver, Colo.	91.9	118.4	118.4	18	5558	Morrison-Knudsen Inc. & Assoc.	17 Apr 59	7 Apr 61	Jul 61
	Lowry II	Denver, Colo.					5654	Morrison-Knudsen Inc. & Assoc.	12 Jun 59	1 Jun 61	Jun 61
	Ellsworth	Rapid City, S.D.	42.7	49.6	43.2	18	5919	Leavell-Scott & Assoc.	8 Dec 59	15 Dec 61	Dec 61
	Beale	Marysville, Cal.	41.1	44.6	44.3	18	2140	Peter Kiewit Sons Co.	15 Jan 60	1 Feb 62	Feb 62
	Mt. Home	Mt. Home, Idaho	43.3	42.9	43.1	16	3565	Kaiser-Raymond-Macco-Puget Sound	8 Feb 60	1 Apr 62	Apr 62
	Larson	Moses Lake, Wash.	46.1	45.9	45.7	33	3552	MacDonald-Scott & Assoc.	20 Nov 59	31 Mar 62	Apr 62
			265.1	301.4	294.7						
TITAN II	Davis-Monthan	Tucson, Ariz.	77.4	70.2	67.1	7	** 2	J. A. Jones Co.	30 Nov 60	15 Jan 62	Jan 62
	McConnell	Wichita, Kans.	76.2	70.0	66.9	3	** 8	Fuller-Webb-Hardeman	14 Dec 60	15 Feb 62	Feb 62
	Little Rock	Little Rock, Ark.	76.2	69.8	66.9	3	** 9	Hardaway-Oman-Farnsworth	21 Dec 60	15 Apr 62	Apr 62
			229.8	210.0	200.9						

avy Strategy of 'Finite Deterrence'

part of the contents of McNamara's recommendations that were submitted to the White House after a month-long study of U.S. defenses.

Kennedy said McNamara's recommendations "talk about a general strengthening of our Armed Forces including many areas." He specifically said "part of (McNamara's) recommendation is to strengthen conventional forces."

Asked if the recommendations meant a lessening of emphasis on nuclear weapons or U.S. capacity to use them, Kennedy said:

"I have not heard that. We have reached no decision which would indicate that there has been a change in our reliance. If we do reach a change in our reliance in new weapons, we will make it very clear. But no such change has been reached at the present time. What we are anxious to do, of course, is to see conventional forces strengthened, not only in Western Europe but throughout the world."

Kennedy said he expected to complete his study of McNamara's recommendations in about two weeks and he would then send the final version of the Administration's defense recommendations to Congress.

• **Army-Navy score?**—The President's words glossed over what appeared to be a major strategy victory for the Navy and Army.

Both services have charged for years that the Air Force was being allowed to develop an "over kill" capacity while the nation's limited war forces were being starved. Army and Navy planners have said that Russia and the United States were rapidly approaching a period of nuclear stalemate when the beginning of an all-out nuclear war by either side would result in mutual suicide. Therefore, they argued that the United States must build up its limited-war forces to be ready to counter Soviet thrusts around the world.

On the other hand, the Air Force has argued that the United States must maintain strategic forces capable not of retaliating against enemy cities but of surviving an initial attack and destroying the enemy's forces. The Air Force has called this strategy "counter-force" as opposed to "finite deterrence."

In line with current intelligence reports, such a missile force has not been planned for deployment with the next few years. Therefore, if force levels are increased only somewhat, there would—in Kennedy's word—be "no change in our reliance" on nuclear weapons in that sense.

• **Rusk's position**—However, a definite possible shift in U.S. strategy was foreshadowed in the now-famed memo submitted to the Defense Department by Secretary of State Dean Rusk.

Rusk urged an increase in U.S. non-nuclear forces and the playing down of U.S. readiness to use nuclear forces. Rusk's position, later hedged, appeared to be that the United States should not necessarily commit itself in advance to the use of nuclear weapons.

If followed, such a policy could make the defense of Western Europe impossible without a massive buildup of conventional ground armies on the continent.

The Russians are reported to have 20 to 30 divisions ready to march in Eastern Europe.

• **Base 'scramble'**—The testimony released by the House Subcommittee offered a stark look at the difficulties the Administration faces in any plan to speed up deployment of land-based ICBM's.

Contractor after contractor complained to the subcommittee that the program was confounded in a maze of red tape. They charged:

–Modification on top of modification "have not only caused a major increase in the scope of the contract(s) but have drastically changed the character of the work . . . into a confused catch-as-catch-can scramble."

–Contractors are financing the program out of their own money because they are unable to regain unanticipated costs through the fixed-price contract system.

–Construction drawings have been issued in a slipshod fashion with "numerous inaccuracies, inconsistencies and omissions."

–Although contracts are with the Army Corps of Engineers, the Air Force, the architect engineers or the weapon system manager has controlled almost all decisions.

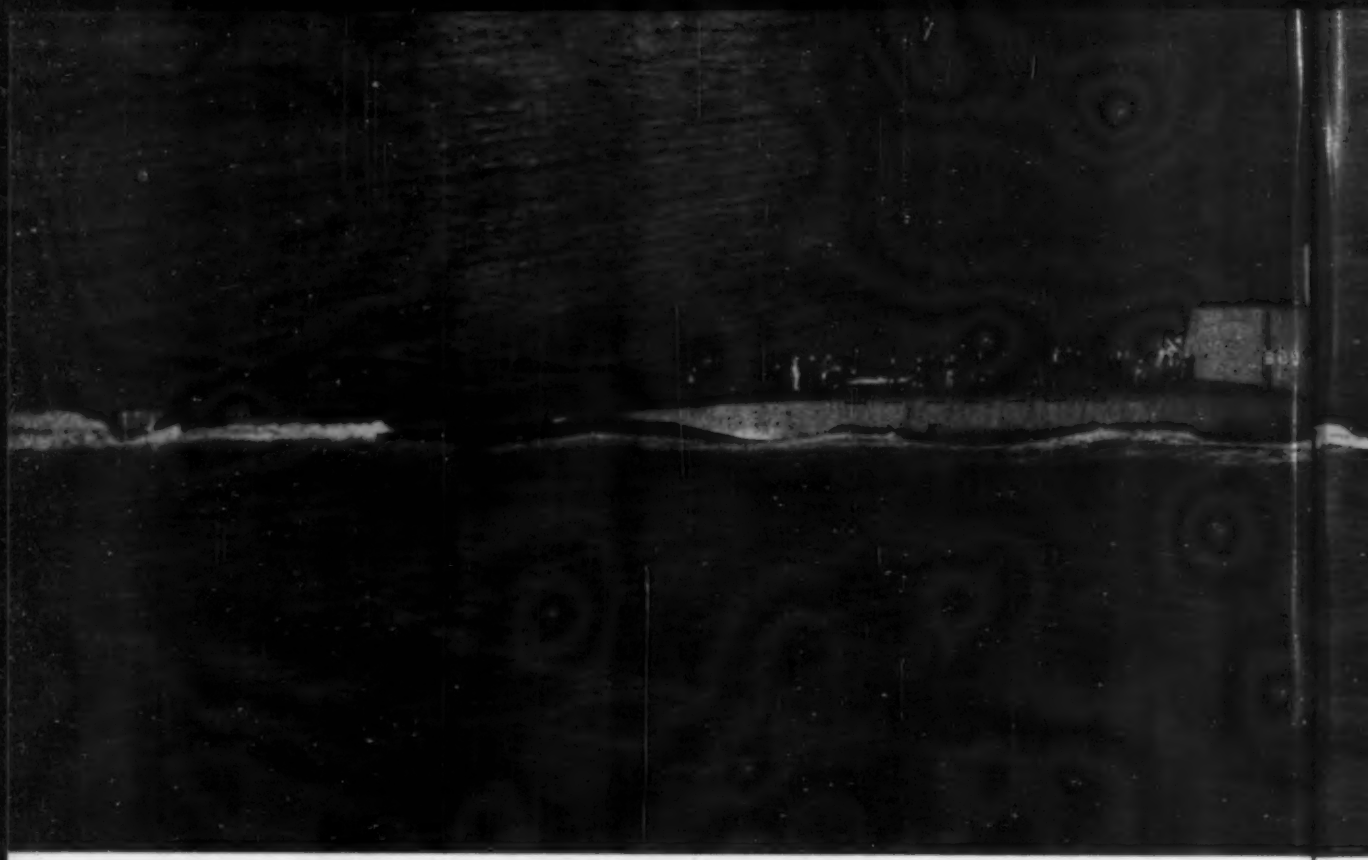
• **Air Force replies**—Joseph Charyk, Undersecretary of the Air Force, charged in a letter to the subcommittee that there were "flagrant misrepresentations" in some of the testimony. He also noted dryly that while the contractors were quick to point out difficulties resulting from frequent change orders they failed to mention that most documents that they received were notices that they were behind in their work.

In rebutting the charges, Charyk offered an interesting insight into the urgency put behind the base-building program by the Eisenhower Administration. He disclosed that construction costs soared $90 million last summer mainly because contractors wrongly concluded from a Pentagon pep talk that expense was secondary to speed.

One thing that the testimony made increasingly clear was that any attempt by the Administration to speed ICBM deployment would call for recognition by all concerned that the effort must be on a wartime scale.

ORIG CONTR COMPL DATE	CURR CONTR COMPL DATE	SCHED PROGRESS	ACT PROGRESS	ACT OR EST COMPL DATE	ORIG CONTR AMT	CURR CONTR AMT
58	Mar 59	100	100	29 Mar 59	$ 7.1	$14.1
59	Aug 59	100	100	20 Aug 59	6.0	8.6
60	Aug 60	100	100	4 Aug 60	12.9	16.7
59	Sep 59	100	100	30 Sep 59	11.8	17.9
60	Jul 60	100	100	25 Jul 60	12.4	16.5
61	May 61	98	97	1 May 61	22.1	25.9
60	Aug 60	100	100	2 Nov 60	6.9	9.0
60	Sep 60	100	100	9 Sep 60	1.4	1.6
60	Nov 60	100	99	1 Apr 61	7.1	9.3
60	Nov 60	100	100	11 Nov 60	6.5	11.0
60	Jun 60	100	100	30 Aug 60	1.6	1.8
60	Mar 61	99	97	14 Mar 61	6.9	13.3
61	Jun 61	90	88	26 Jun 61	23.4	34.3
61	Jul 61	80	80	28 Jul 61	23.0	27.0
61	Aug 61	66	70	16 Aug 61	20.9	22.6
61	Sep 61	73	62	6 Sep 61	20.1	23.3
61	Nov 61	49	34	10 Nov 61	22.1	22.2
61	Nov 61	40	29	27 Nov 61	24.4	24.4
61	Jul 61	99	97	1 Aug 61	40.7	55.3
61	Jun 61	99	95	1 Nov 61	26.9	34.0
61	Dec 61	77	81	15 Dec 61	32.9	34.1
62	Feb 62	76	83	1 Feb 62	30.2	30.9
62	Apr 62	50	50	1 Apr 62	28.9	28.9
62	Apr 62	77	72	10 Apr 62	31.6	31.8
62	Jan 62	1.9	3.2	1 Nov 62	27.8	27.8
62	Feb 62	1.5	2.5	1 Dec 62	30.8	30.8
62	Apr 62	0.4	0.8	1 Feb 63	28.7	28.7

Chart from hearings of House Military Construction Subcommittee.



Fourth Polaris Submarine Joins At

San Diego Union Photo

"GREATEST SHIP ever built," says Cmdr. W. E. Sims, skipper of one of alternating crews.

USS Theodore Roosevelt heads for firing tests off Canaveral and later modification before going on 'on-line' patrol status

THE THEODORE ROOSEVELT, on its way to the Atlantic Missile Range for firing tests, boosts to four the nuclear-powered *Polaris* subs in the Atlantic Fleet.

The ship will pick up instrumented *Polaris* missiles at the Naval Weapons Annex, Charleston, S.C., then proceed to Port Canaveral, its operational base for the firings.

Before going on "on-line" patrol status in the Atlantic, the ship will put in at Electric Boat Div., General Dynamics Corp., Groton, Conn., for modifications, including new-design vortex generators to improve the hull's hydrodynamic characteristics.

Although communications remain a problem in transmission from the sub, the "go" signal can be received in a matter of two or three minutes—a reaction time comparable to weapons of the Strategic Air Command.

Missiles can be fired in any sea except under ice. The guidance computer constantly corrects the missile guidance package in accordance with the ship's movements. Targets can be changed, if necessary, in a few minutes. ⁂

Sea Diego Union Photo

HELMSMEN PREPARE to take TR down in a 20° dive. Vessel's officially announced operational capability of 400 ft. deep is "conservative."

ns Atlantic Fleet

"MUSHROOM FACTORY"—as ship bottom is called. Polaris launching tubes are shown with hatches at base.

LAUNCHING BOARD for all 16 Polarises. The TR can get off all the missiles in its arsenal in less than 15 minutes.

Flood Sends M/R Zeus Report to Kennedy

PRESIDENT KENNEDY is expected to decide shortly whether to commit the Nike-Zeus A—ICBM to limited production (M/R, Jan. 30). The verdict will be included in his overall plans for revamping the defense budget.

House Majority Leader John W. McCormack, along with other congressmen, backed immediate production—despite arguments from DOD's Herbert York that Zeus should be proven first.

The debate was climaxed when Rep. Daniel Flood of the House Defense Appropriations Subcommittee sent the following letter to Kennedy:

Dear Mr. President:

Sharing your deep, personal concern regarding the manifold aspects of our national security, I send to you this copy of the remarkable series of articles concerning America's antimissile missile weapons systems, the *Nike-Zeus*, which appeared in the Jan. 30 issue of the authoritative technical journal, MISSILES AND ROCKETS magazine.

This series, in my experience, represents the most thorough and comprehensive analysis of a major weapons system presented in public print during these recent years of revolutional progress in science and technology. I have this day sent a copy to every Member of the House of Representatives.

On February 13, in an address to the House, a copy of which I enclose, I expressed the view that this nation needs, and must have as soon as possible, an active defense against incoming intercontinental and subarine-launched ballistic missiles.

I urged that we begin immediate production of the U.S. Army *Nike-Zeus* antimissile missile, America's single weapons system specifically designed to counter the threat of a Red-triggered nuclear hailstorm.

Mr. President, you will recall that as early as 1959 Congress perceived the critical need for this action and appropriated $137,000,000 to initiate production of the first batteries of *Zeus* killer-missiles. The previous Administration failed to act.

In this day of surging breakthroughs in the area of sophisticated weapons systems, the United States cannot afford the loss of a month of critical lead-time. To date, we have lost more than a year of *Zeus* production.

Meantime, intelligence reports reveal that Soviet Russia is laboring at highest priority and with maximum resources to be first in fielding an anti-ballistic missile weapon shield for centers of population, of industry, and of military might.

If the Communists succeed in outpacing this nation, if they are the first to establish the highly effective, specialized defense which neutralizes ballistic projectiles, they will seize from the U.S. her present power to retaliate in self-defense against mass-missile attack.

America would sit naked, nuclear-weak in the diplomatic councils of this world.

At this crucial juncture of time and events, Mr. President, it is my hope and trust that you will find the enclosed article series of significant value in your contemplation of the moves this nation must make into the new frontiers of national and world security.

I profess to you, with all intensity at my command, the belief that the American people—and citizens throughout the nations of the Free World—would hail a dramatic decision by this Administration to loose the *Zeus*, to put it into immediate production, to hasten the day when U.S. and allied froces at last can stand armed and ready with the ballistic boxing gloves so desperately needed for defense against the ceaseless threat of Communist world-wide nuclear aggression.

Hughes Develops Optical Space Radar

'Colidar' device reported to have desired small size, low weight and power needs—and potential long range

AN OPTICAL RADAR with a potential range in space of hundreds of miles has been developed by Hughes Aircraft Co.

Called "Colidar" (coherent light detection and ranging), the device uses the monochromatic light from the ruby laser (or optical maser) to beam energy to distant targets. The energy reflected back to a receiver and measured provides information on the size and distance of the target.

Dr. Rex C. Mack, Hughes senior scientist, said that the Colidar has the low weight, low power requirement, and small size that will allow it to be carried in a satellite and provide "the first practical long-range radar for use in outer space."

Hughes was the first to announce successful development of the basic laser (M/R, July 18, 1960). Their announcement of an optical radar, however, followed by almost two weeks the disclosure of a three-mile operating system developed by U. of Michigan (see Technical Countdown, p. 21).

The range of the Colidar is reported to be nearly six miles in the earth's atmosphere. In outer space its range would be hundreds of miles with only a slight expenditure of power, Mack said. The realization of such a practical application is predicated upon expected advances in the state of the art in beam formation, power sources, and receivers.

• **Operation**—The optical radar uses the ruby laser as a transmitter, and an optical system coupled to a photoelectric tube as a receiver.

The laser—(light amplication by stimulated emission of radiation) generates a highly collimated, monochromatic beam of light. With the ruby crystal presently used, the wavelength of its radiation is 6943 angstrom units (.00006943 cm).

The ruby crystal is 3/8 in. in diameter and 1½ in. long. Surrounding the ruby is a spiral flash tube. When the flash tube is discharged, the monochromatic beam of red light emerges from the partly transparent silvered surface at one end. Power outputs in excess of 1 kw have been observed. The beam width is less than ½° and the spectral line width less than 0.01 angstroms.

When the output of the laser is fed through a lens system, the beam width is narrowed down considerably. The very narrow beam width is a desirable feature for optical radar application since it ensures a very high gain system—with long range for relatively small power requirements—and a very high angular resolution.

The collector (or receiver) is nothing but a telescope. The mirror in the telescope collects and focuses the reflected light. After focus, the light passes through a narrow band light filter which reduces the "noise" in the returned signal. Finally, the signal is amplified and processed.

A portion of the light pulse from the laser triggers a timing system to note the time the pulse is initiated. The pulse then travels to the target, is reflected back to the collector, and the elapsed time measured. Range is calculated from this measured time.

"AEROBALLISTIC"

With the firing of this unique hypersonic missile from Cape Canaveral in February 1959, a new word was born. The word, AEROBALLISTIC, was coined by McDonnell to describe the new aerospace vehicle concepts demonstrated by this firing. Level flight was achieved at over Mach 5 within the atmosphere.

The principles proved by McDonnell's Aeroballistic missile are the first major breakthroughs in the design of multi-mission spacecraft for earth-to-space and space-to-earth transport of men and payloads. Low lift-off weight, efficient orbital configuration, low heat re-entry and precise atmospheric maneuverability are provided in a re-usable Aeroballistic vehicle. The Aeroballistic space mission terminates with a conventional runway landing.

MCDONNELL

Phantom II and F-101 Fighter and Attack Aircraft •
Project Mercury and Aeroballistic Spacecraft •
Talos Airframes and Propulsion Systems •
Quail Decoy Missiles • Rotorcraft •
Electronics Systems • Automation

MCDONNELL AIRCRAFT • ST. LOUIS, MO.

Today's SERGEANT ranks with the toughest

After some two-score highly successful test firings, the U. S. Army's SERGEANT guided ballistic missile ranks with the toughest and most dependable "sergeants" of history. This "missile behind the man" with its great mobility and swift ability to concentrate massive firepower when and where needed, will provide powerful support to the modern Field Army.

Developed by Jet Propulsion Laboratory, under the direction of the Army Ordnance Missile Command and produced and managed by Sperry Utah, this 85-mile range inertially-guided surface-to-surface missile has met the most exacting design goals of the military. Solid-rocket propelled, it approaches conventional artillery in speed of emplacement and displacement. Its highly precise, inertial guidance system is completely self-contained, requires no external control, is invulnerable to any known countermeasures.

Now being geared for full scale production at Sperry's Salt Lake City facility . . . built and packaged for the roughest handling and environments... SERGEANT, when operational, will add formidably to our Nation's arsenal of firepower.

SPERRY UTAH

(We invite your inquiry regarding the outstanding opportunities available with the Sperry-Sergeant missile team.)

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Technical Countdown

ADVANCED MATERIALS

More Ceramics Research Needed

Increased emphasis on ceramics research is one of the major recommendations contained in a report on new defense research projects compiled by DOD. The report also envisions modifying current programs in metals, semimetals, rare earths, plastics, fabrics, semiconductors and thermo-electric materials.

Plastic Cases for Giant Solid Boosters?

High-strength steels would be the choice for the motor chambers of multimillion-pound solid boosters if the rockets were to be developed in 13 months. But if the development time is stretched to around 30 months, plastics look very attractive, says Thiokol's Dr. Harold Ritchey.

Russians Think Ahead

The Soviets have published calculations of the energy necessary to operate a 50-ton vehicle for one year with a photon engine. The initial mass of the theoretical rocket would be 200 tons; conversion of 150 tons of fuel into photons during the period of operation would equal a consumption of 3.76×10^{15} kwh. This somewhat exceeds the total amount of electrical energy produced by all of the earth's powerplants during 1957.

SUPPORT EQUIPMENT

New Telemetry System Completed

An experimental version of a new telemetry system capable of three times the range of any previous system has been built by General Electric MSVD. It says present systems require about 10 times the power of the new "Synchrolink" digital equipment. The system, classified as PCM/PS (pulse code modulation with phase-shift keying) uses a threshold-free synchronous receiver that permits signal detection at extremely low (about –10 db) S/N ratios.

Optical Radar Demonstrated

Scientists at U. of Michigan have successfully demonstrated an experimental optical radar. Intense red light from a laser (optical maser) was beamed at a target three miles away and the reflected signals successfully measured. Optical radars should be capable of recording pictures of distant objects with good resolution under conditions unsuitable for conventional cameras. Due to the much higher frequencies used, the laser requires much smaller antennas than does radar.

Speech Compressor Built for AF

Hughes Aircraft has developed a "voice condenser" for the Air Force that shows promise of relieving present traffic congestion on radio communications channels. Called a "vocoder," the device eliminates extraneous sounds in voice communications and transmits only the basic sounds. In its analog mode, the vocoder requires only one-tenth the frequency bandwidth of conventional channels. It also operates in a digital mode which requires a full bandwidth (3000 cps) but makes the transmission much less subject to interference.

Navy to Get Outsize Seaborne Radar

A 10-ton attack warning radar—one of the largest ever to go aboard a ship—is now undergoing final test by Raytheon prior to delivery to the Navy. The high-powered AN/SPS-38 is reportedly almost impossible to jam.

PMR Gets Transit Office

The Navy has assigned Pacific Missile Range full responsibility for establishing, operating, and maintaining the global *Transit* navigational satellite tracking network. The new office at Pt. Mugu is headed by Cdr. J. C. Quillin, Jr. Three *Transit* tracking stations—in Brazil, Alaska, and Hawaii—are already in operation. Six other stations are being planned for locations in the Far East, South Central Asia, and Africa.

Telemetry Standards Issued

IRIG (Inter-Range Instrumentation Group) has issued its latest telemetry standards (Document No. 106-60), the first complete revision since 1956. The new publication includes recent recommendations for standards for PCM and magnetic recorder reproducers as well as a glossary of terms and frequency criteria. Copies may be obtained from IRIG (White Sands Missile Range) or ASTIA.

New Computer Uses Pneumatic Elements

A pneumatic digital computer, under development at Kearfott, will be able to operate in temperatures from –100° to +2000°F and in virtually any radiation environment. The new device is said to be equal in certain applications to an electronic or mechanical computer and, in addition, will be smaller, cheaper, more reliable, and easier to service and test. Basic unit of the computer is a bistable element (flip-flop) that operates on compressed gas. Switching time is ten microseconds. Two thousand of these elements, with interconnections, can be packaged in one cubic inch. A complete medium-size pneumatic computer would occupy about the same space as a baseball.

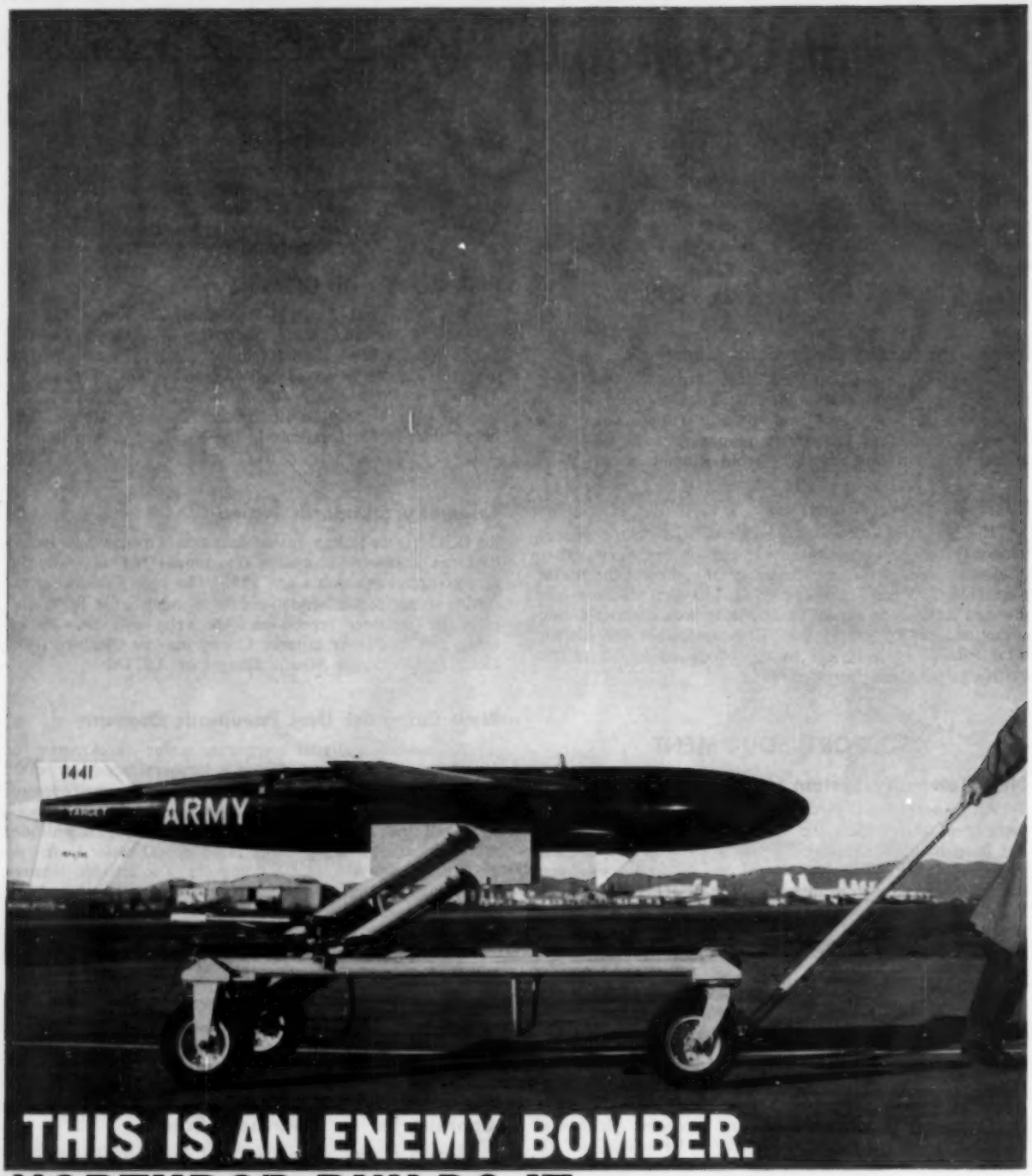
ASTRONAUTICS

Contract Let for 'Starched' Echo

Design of the 135-ft. rigidized *Echo* satellite will get under way soon. NASA has awarded a $400,000 contract for R&D, fabrication and testing of rigidized inflatable spheres to G. T. Schjeldal Co., builder of the *Echo I* satellite. The 500-lb. laminated aluminum foil and Mylar spheres —scheduled for first orbit launch next year—are expected to retain their shape in space without internal pressure.

Contracts for Javelin and Journeyman

Aerolab has a NASA contract to engineer payloads, launch vehicles and analyze data for at least six *Argo D-4 (Javelin)* and several *Argo D-8 (Journeyman)* rockets. *Javelin* has boosted 50 lbs. to 700-800 miles. *Journeyman* launched the *NERV* payload of 83 lbs. to almost 1200 miles last fall.



THIS IS AN ENEMY BOMBER.
NORTHROP BUILDS IT.

On a radar screen, the RP-76 target missile can look as big as the largest enemy bomber. Rocket powered, it flies faster than sound, operates above 70,000 feet. Yet this little giant is less than ten feet long, weighs just over 300 pounds, and parachutes down for re-use after completing its run. It is the heart of the Army's program for training the ground-to-air missile crews who guard our cities. The complete target and tracking system is made, managed and serviced for the Army by **RADIOPLANE**
A DIVISION OF
NORTHROP

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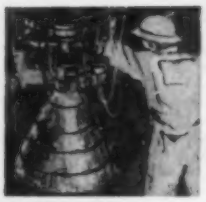
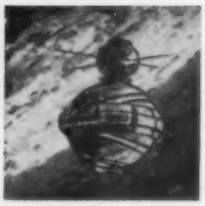




MARCH, 1961

MISSILES and ROCKETS

ASTROLOG

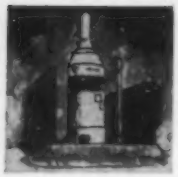
Current status of U. S. missile and space programs plus all orbiting satellites

Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	Army Signal Corps, prime; GE-Bendix prime for polar-orbiting phase; Bendix prime for 24-hour satellite	Twenty-four hour instantaneous repeater communications satellite; 1000 lbs.; program incorporates Projects STEER and DECREE	R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first ATLAS-CENTAUR launchings late '62
ANNA (Army, Navy, AF, NASA)	No contractors announced	Geodetic satellite; 50-100 lbs.; probably spherical	Study completed; R&D program appears imminent
★**AEROS** (NASA)	No contract announced	24-hour weather satellite to be boosted by CENTAUR or SATURN	Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget
APOLLO (NASA)	Convair, Martin, GE	Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN	Six-month studies in progress; plans delayed
★**ARENTS** (ARPA)	Convair, prime	Satellites to investigate deep space; 22,000 n. mi. orbits; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings begin early '62
ASP (Air Force)	No contracts announced	Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space	Study
BAMBI (ARPA)	No contracts announced	Satellite system capable of intercepting enemy satellites	Studies
★**COURIER** (Army)	Army Signal Corps, prime; Philco, payload; Radiation, Inc., antennas; ITT, ground stations	Delayed repeater communications satellite; 51 in. diameter, 500 lbs.	COURIER 1B placed in orbit Oct. 4, transmitted messages and pictures. Program now phased into ADVENT
CSAR (Air Force)	No contracts announced	Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors	Studies; possibly operational mid-60's
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems	Launchings: 21; capsules recovered from orbit and air snatched; after orbiting earth one to three days; simians to be put in capsules in early 1961
★**DYNA-SOAR I** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link	Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN II booster	R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway; R&D space flight about 1966

★ **Indicates change since January, 1961 Astrolog**

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	In orbit since Aug. 12
★MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite; 1 ton capsule boosted by ATLAS	First manned capsule launching by REDSTONE now scheduled this spring. First manned orbit shot expected late 1961 or early 1962. Chimp in capsule launched successfully downrange by REDSTONE Jan. 31; ATLAS-capsule shot with fix succeeded Feb. 21
★MIDAS (Air Force)	Lockheed prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 partial success; components being tested by DISCOVERER
★NIMBUS (NASA)	GE prime	2nd generation weather satellite; THOR-AGENA B booster	First launching scheduled for late 1962
OAO (NASA)	Grumman, prime; Westinghouse, electronic components	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B	First flight scheduled in late 1963
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963
★OSO (NASA)	Ball Brothers, prime	350 lb. orbiting solar observatory; THOR-DELTA booster	First flight planned summer 1961
PROSPECTOR (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster	First flight planned by 1965; study contracts to be awarded in 1961
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster	R&D; first flight planned 1961; first lunar landing planned for 1962, instrumentation to include seismometer
★REBOUND (NASA)	No contract announced	System of 12 or more multi-launched passive communications satellites	First orbital flight scheduled for 1962
★RELAY (NASA)	No contracts announced	Systems of dozens of 85-lb. active repeater communications satellites. Commercial system planned	Contract to be awarded soon
SAINT (Air Force)	RCA, prime	Anti-satellite satellite inspection system; to be complemented by interception system; ATLAS launched	R&D underway
★SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg. First launch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program; components being tested in DISCOVERERS
SLOMAR (Air Force)	Lockheed and Martin, prime	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in December
★SURVEYOR (NASA)	Hughes, prime	Soft-landing 100-300 lbs. instrumented spacecraft on moon; ATLAS-CENTAUR booster	First moon flights 1963
TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner	R&D; first launching last April; second Nov. 23, both successful. At least one more planned
★TRANSIT (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.	TRANSIT 1B R&D satellite in orbit April 13; 1IA plus piggyback satellite in orbit June 22, four-satellite TRANSIT system scheduled operational 1962; TRANSIT 1IIB lanuched into poor orbit Feb. 21
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered.	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA



Missiles and Rockets

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ARM (Air Force)	No contract announced	Anti-radar missile; air to surface	Studies; plan for separate missile shelved at least temporarily
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater rocket torpedo; nuclear	R&D
★**ATLAS** (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	79 launchings; 51 successes, 12 partial, 16 failures; 11 bases for 13 squadrons; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 9 to 12 launchers operational—40 to 60 expected in 1961. First successful "E" shot Feb. 24
BOMARC-A (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
BOMARC-B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear	B models being produced; a B test bird intercepted simulated target 345 miles away Oct. 14; R&D launchings: 18; 10 successes; 8 failures
★**BULLPUP** (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion	Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters; second source contractor being sought
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime manufacturer; Daystrom, U.S. licensee	20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational this year; first NATO deliveries also this year
★**EAGLE** (Navy)	Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs.; Mach 4; solid	R&D; Missileer production run reported to be 120 in next few years if plans refunded; first EAGLE flight test expected early '62
FABMIDS (Army)	Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile anti-missile defense system	Each of six contractors have $250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 R&D; GAR-11 operational in near future
GENIE (Air Force)	Douglas, prime; Aerojet-General propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes	Operational; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another
HONEST JOHN (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; can be made mobile	To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape
★**LACROSSE** (Army)	Martin, prime; Martin, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped
★**LAW** (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light anti-tank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter	R&D under AOMC
★**LITTLE JOHN** (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	First 4-launcher battalion operational this winter
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
★**MACE** (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has more than 1200 m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; to be in Okinawa, Korea
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher	R&D; NATO may buy
★**MINUTEMAN** (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; first R&D flight (all stages igniting) from Cape Feb. 1 a success; tactical rail system tests completed; 3 squadrons at Malmstrom; 3 at Ellsworth AFB, S.D.; Pease AFB, N.H., being surveyed for more
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA prime	Surface-to-surface; 10-20 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokol propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S. sixty-eight more to be phased out and replaced with NIKE-HERCULES
★**NIKE-HERCULES** (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands, 14 R&D launchings; 8 successful, 4 partial, 2 failures. Complete system tests now scheduled for mid-'62
★**PERSHING** (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE; 12 R&D launchings: 10 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 2 failures. Operational late 1961

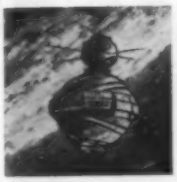
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D	87 launchings of test vehicles; 61 successes; 21 partial; 5 failures; 15 also launched from submerged subs —all cleared surface; 10 successful flights, 5 failures. Two subs each with 16 missiles operational; Total authorized: 19. Cruiser Long Beach also to get 8 missiles
QUAIL (Air Force)	McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; jet powered	Deployed at SAC bases; carried by B-52
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Philco/Convair Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
REGULUS I (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; REGULUS II used as target drone
SEMPER (Marines)	No contracts announced	Believed to be an air-launched missile	R&D testing at Pt. Mugu
SERGEANT (Army)	Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	In production
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★**SKY BOLT** (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers	R&D; to be purchased by British; operational 1964-65; test-launching to be from Eglin AFB, Fla. Spending cut jeopardizing program schedule
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Pratt & Whitney/ABL, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	One squadron of about 20 missiles at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract extending range, altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime; G.E., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army; decision on procurement due for some time
TALOS (Navy)	Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational on Missile Destroyer Adams in Oct.
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs.; HE warhead	Navy buying from Norway to equip two destroyer escorts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed this year
★**THOR** (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 65 military launchings: 44 successes; 11 partial; 10 failures; 44 scientific launchings: 36 successful, 2 partial; 6 failures
★**TITAN** (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed	29 launchings test vehicles: 19 successes; 4 partial; 6 failures. 9 sites for 14 squadrons named; TITAN I operational mid-1961 despite delay caused by silo blow-up at Vandenberg; TITAN II scheduled operational early 1963

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional	Operational

Space Vehicles

AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start engine about double fuel capacity of AGENA A	Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR
ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 380-lb. vehicle around moon or send into deep space	Program ended with explosion of booster in flight Dec. 14. Launchings: 4; failures, 4 (3 failed in flight)
★**BLUE SCOUT** (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	Solid multi-stage booster based on SCOUT components	Launchings 3:2 successes; 1 partial
CENTAUR (NASA)	Convair, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe	First test flight in 1961; first engine delivered
★**DELTA** (NASA)	Goddard, prime; Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity	Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe
JUNO II (NASA)	Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, propulsion	Early deep space booster; small payload	Phasing out
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-12 million lb. booster plus upper stages	R&D on 1.5 million lb. F-1 engines
ORION (Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone
★**PHOENIX** (Air Force)	No contracts announced	Recoverable booster—possibly a modified F-1.	Studies
PROJECT 3059	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lbs. thrust class	Research determining feasibility; NASA contracting complementary studies with United Technology
★**ROVER** (NASA, AEC)	No prime announced	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	Contracts to be let early 1961
★**SATURN** (NASA)	Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload	Second static tests ended; flight booster to be static-tested this spring for summer flight; flight with live upper stages scheduled 1963
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	SCOUT 4 launched. EXPLORER IX Feb. 16. Four more SCOUT flights in '61 completes R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine	THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER
THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61



Satellites in Orbit

***EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 220 m., apogee 1129 m., period 106.8 min. (Discovered Van Allen Belt); not transmitting.

***VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 407, apogee 2444, period 133.8; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. Believed to be in orbit around Sun on 15-mo. cycle; not transmitting.

***VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 343, apogee 2052, period 125.4; inclination to equator 32.88°; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun, and achieved primary mission—earth-moon trajectory; not transmitting.

***EXPLORER VI "PADDLEWHEEL"** (142 lbs.) U.S. Launched 8/7/59, est. life to Aug., 1961. Orbits earth; initial perigee 156, initial apogee 26,357, initial period 12½ hrs.; present orbit uncertain.

***VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 315, apogee 2318, period 129.8; not transmitting.

***EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 671, period 101.2; transmitting.

***PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun, interplanetary environment probe; completed one full orbit 1/16/61; not transmitting.

***TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 467, period 99.1; transmitting.

***TRANSIT 1B** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 426, period 95.1. First R&D navigation satellite. Not transmitting.

***SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 191/429 on 5/19; last reported—perigee 175, apogee 352, period 93.1 Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

***MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 296, apogee 317, period 94.3. Telemetry for IR scanning failed two days after launch. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apogee 650, period 101.6; transmitting.

NRL SOLAR RADIATION SATELLITE 1 (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Transmitting.

***ECHO 1** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 624, apogee 1305, period 117.1. First successful orbiting of passive communications satellite.

***COURIER 1B** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 604, apogee 751, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

***EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 304, apogee 1371, period 112.6. Provides ionospheric measurements for communications. Transmitting.

***TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 461, period 98.2. Transmitting.

***DISCOVERER XVIII** (2100 lbs.) U.S. Launched 12/7/60. Orbits earth; perigee 143, apogee 300, period 91.7. Capsule air-snatched and recovered after 48 orbits; contained human bone marrow, cancer cells, other biological specimens.

***SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth. First R&D reconnaissance satellite.

***SPUTNIK VII** (14,292 lbs.) Russia. Launched 2/4/61. Orbits earth; perigee 120, apogee 186, period 89.4. Not transmitting.

***VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61. Expected to reach Venus by mid-April.

***SPUTNIK VIII** Russia. Launched 2/12/61. Orbits earth; perigee 123, apogee 198, period 89.7. Launch platform for VENUS PROBE.

***EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 394, apogee 1607, period 118.4. A 12-ft. "polka dot" balloon.

***DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 201, apogee 450, period 95. No attempt to recover 300-lb. capsule because of malfunction.

***DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 155, apogee 670, period 97.8. Carried IR equipment for MIDAS program to measure background radiation from earth.

***TRANSIT 1IB** (250 lbs.) U.S. Launched 2/21/61, est. life: weeks. Orbiting earth; perigee 110, apogee 613, period 96.3. LOFTI, 54-lb. piggyback satellite, failed to separate.

(Orbital data is latest official information as of Feb. 24)

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Advanced programs now in progress at Martin include: vehicle stag— ...ligati... operization. The professional mind which is seeking the freedom to inquire will find unusual stimulation, association, and recognition. To participate, write to N. M. Pagan, Director of Technical & Scientific Staffing, (Dept F-1), The Martin Company, P.O. Box 179, Denver 1, Colorado.

MARTIN

DENVER DIVISION

Cooled Nozzles Developed for Future

Aerojet-General reports successful testing with metal coolants up to 6500°F and predicts even greater capacity for solids and hybrids yet to come; present programs don't need cooling

SACRAMENTO, CALIF.—Development of a cooled solid-rocket nozzle for 2000°F operation in exhaust temperatures over 6000°F has been revealed by Aerojet-General Corp.

The simply designed unit uses low-melting metal coolants to achieve the temperature reduction.

Dr. Ernest R. Roberts, assistant manager of Aerojet's solid rocket plant, said the nozzles can cope with 6500°F—plus temperatures expected to result from solid propellants by 1967—and will also be able to handle anticipated hybrid rocket temperatures upwards of 7300°F.

In Aerojet's evaluation of the system, lithium, magnesium and sodium were run through many tests, with the final coolant recommendation depending on factors in the individual rocket under design. Lithium was the most extensively tested.

Weights of the cooled nozzles were equivalent to uncooled nozzles, including the coolant weight. The amount of coolant depends on the temperature and burning time expected in the operation.

Despite the successful development, Roberts told M/R he sees no immediate application for such a nozzle because the present programs using large solid rockets are progressing well without nozzle cooling. He indicated that there are future applications.

• **Evaporation cooling**—Hundreds of small-scale tests with various configurations and coolants were conducted, resulting in elimination of any system using moving parts. The final configuration was a simple, double-chambered nozzle, with metal coolant behind the walls of the nozzle.

As heat from combustion melts the metal, vents relieve pressure generated by expansion and vaporization, allowing gaseous coolant to escape. Metal coolants perform without the tanks or pumps required by liquid or gaseous coolants.

In a rocket flight involving horizontal attitudes, momentum prevents the coolant from flowing out the vents, although the vaporized coolant will escape.

Each of the three metals tested has a boiling point several hundred degrees lower than the maximum allowable temperature of the planned structural materials for the design.

COOLED NOZZLE cross-section after 80 seconds at 6200°F. Inner wall is 0.060 in. of molybdenum cooled by magnesium.

Evaporation Cooled Nozzle

Lithium, with the highest heat of vaporization of all the metallic coolants, provides cooling with the least weight penalty. Sodium, with the lowest boiling point of any metallic coolant at any given altitude, results in the coolest nozzle. Magnesium was about halfway between the other two in critical properties.

• **Molybdenum nozzles**—Aereojet engineers also found that once the metallic coolant begins to boil, the temperature distribution on the wall of the nozzle subject to direct rocket blasts remains constant. The firing duration is limited only by the amount of coolant which can be carried without prohibitive weight penalties.

The research program indicated that best results were achieved when the nozzle inner wall is composed of a material of high thermal conductivity, such as molybdenum. Better heat transfer to the coolant is thus obtained.

Additionally, a thin insulation coating applied to the inner throat of the nozzle will reduce the temperature of the surface. Such materials used structural plastics, carbon, carbides, carbon cloth, and other refractories.

There are problems if the nozzle is too cool, Roberts said. If solid particles contained in the propellant (such as aluminum or other additives) change phase during combustion, they will condense on the nozzle wall in event of overcooling. Elimination of additives removes this problem.

Actual tests showed success at durations of 60 to 80 seconds and temperatures of 6200°F. The inner molybdenum wall would ordinarily melt at 4698°F, but wall temperatures were as low as 2000°F.

Lightweight nozzles tested ran for 60 seconds at 6200°F with a two-and-a-half-inch throat diameter, using less than two pounds of coolant during the run. The figure includes 120% excess coolant, the company said.

Aerojet expects to continue the tests in efforts to perfect the nozzle design for much higher temperatures. ⌗

Cleaning Bares Flaws in Missiles

Dow Chemical experts report that arduous cleaning process leads to breakdowns and rejections in liquid ICBM's

by John F. Judge

SHODDY WORKMANSHIP in critical missile system components is being revealed through the extraordinary cleaning procedures applied to liquid-fueled missiles.

Defective welds, poor choices of materials and the use of marginal grades within specified steel types are prevalent today—at a time when these ICBM's are combat-ready.

Dow Industrial Service experts, long familiar with the exacting task of meeting government specifications in cleaning liquid oxygen systems and related components, are finding that some items break down in approved chemical cleaning procedures.

LOX equipment is cleaned by etching—the chemical removal of metal. If a part has a heat-sensitized weld area, the etching baths honeycomb the junction instead of removing a uniform layer of metal.

Use of marginal grades in the 304 stainless steel family lead to fatal damage during cleaning. Even the improper choice of welding rods and poor grinding techniques are uncovered in the baths and result in rejected parts.

• **Meeting tough standards**—The cleaning of missiles and launching systems is rigidly prescribed by Air Force specifications. Particles larger than 150 microns are not tolerated, and the complete absence of hydrocarbons and other contaminants incompatible with liquid oxygen is mandatory.

Achieving this exalted condition is another matter. The Dow Industrial Service, division of Dow Chemical Co., maintains 11 stations across the U.S. devoted to missile cleaning. These stations, or "white rooms," are designed to completely clean critical items before they are placed in service. Mobile equipment is employed to clean parts too large for the room or those within the missile itself.

Each cleaning job has its own peculiarities. The equipment used in the process includes vats containing ultrasonic agitators for solvent and acid cleaning; high- and low-pressure demineralized water for rinsing; dry, oil-free nitrogen; infrared drying ovens; vacuum systems; inspection instruments and standard laboratory tools.

The air in the rooms is filtered of particles down to the 3-10 micron range and maintained under slight pressure at all times. Cleaning solutions, water and purge gas are constantly checked.

Personnel enter through air locks and wear specified clothing. For obvious reasons, items in the rooms cannot come in contact with bare skin.

Dow uses various concentrations of nitric-hydrofluoric acids in the pickling baths. Trichloroethylene is used for degreasing operations, primarily because it is LOX-compatible.

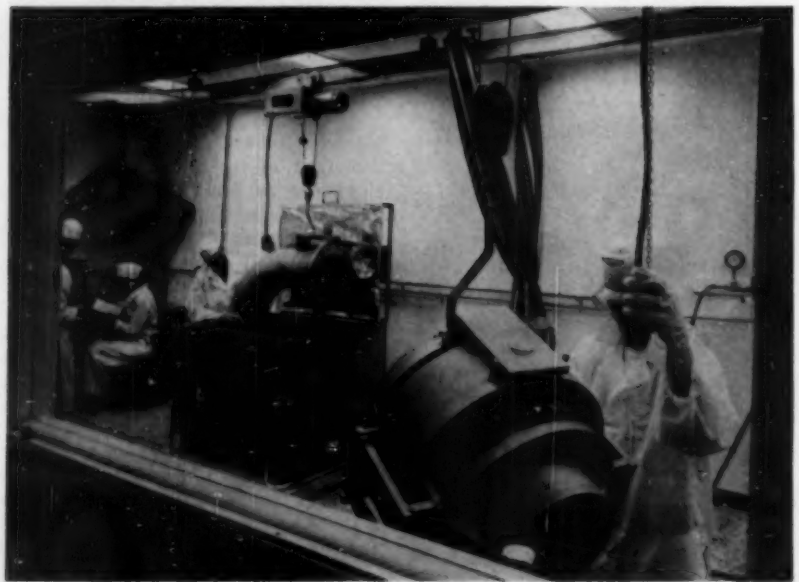
• **Custom tailored methods**—Complex parts generate special techniques. In each case, the procedure fits the problem.

LOX equipment designed into a missile has no spare metal. Consequently, the degree of etching allowed is much less than that accepted for ground support items. If possible, etching is avoided altogether and high-pressure cleaning with water and other solvents is substituted.

Dow experts have developed special foams and foam-forming liquids for cleaning the missile. Bottles, convoluted lines, suction hoses and hydraulic systems have all been successfully cleaned on the spot by Dow teams. Most surfactants are not compatible with LOX but the DIS formulations are free of this complication.

DIS is constantly researching methods and solutions to improve cleaning efficiency and economy. In addition, every new part subjected to cleaning is preceded by data proving that the procedure and materials involved will meet specification limits.

Cleaning operations will be very much a part of the liquid-fueled ICBM launching sites around the U.S. But DIS spokesmen are not aware of any current effort to establish standard operating procedures in maintaining these conditions at operational sites. Even Vandenberg Air Force Base lacks a definite procedure. The absence of such precautions could easily diminish the reliability of our ultimate defense. ⌗



***TYPICAL 'WHITE ROOM' FACILITY** produces parts that far surpass surgical cleanliness. The slightest speck of oil or grease could easily cause an explosion if it came into contact with liquid oxygen.*

Surveyor To Collect Wide Range Of Data

Four television cameras and Hughes-developed soil drill are among variety of scientific instruments designed to conduct four experiments.

by Frank G. McGuire

PASADENA, CALIF.—The *Surveyor* lunar soft-landing vehicle will carry out four varied experiments in data collection during its scheduled 30-day-plus period of operation.

Jet Propulsion Laboratory, which provides technical direction for the National Aeronautics and Space Administration program, lists the experiments as geophysical, television, lunar soil collection and analysis, and particle and field measurement.

Being developed by Hughes Aircraft Co. for JPL/NASA, *Surveyor* will incorporate more than a dozen scientific instruments.

Included will be acoustical devices, ion gages, magnetometers, a drill, neutron activator, geophysical probe, four TV cameras (one with a filter turret for color spectroscopy), seismometer, particle accelerators, mass spectrometers, and other instrumentation.

In event of malfunctions or vehicle damage during flight or while on the moon, a command signal from the Goldstone Deep Space Instrumentation Facility of JPL will cut certain instruments off the power supply, thus conserving power for more vital experiments.

Experiment requirements for each of the seven planned missions may vary, and Hughes expects to vary payload weights and configurations during the run of the two-year project.

• **Four cameras**—One of the most important facets of the payload will be the television capability included in the Hughes design. Three cameras will be mounted on the vehicle, pointing straight up. A fourth will be mounted pointing downward to view the moon during the approach phase, and later to monitor the drilling operation after touchdown.

For the three upward-looking cameras, mirrors will be located for changing the field of view for each unit. A Hughes spokesman said this is more reliable and easier than rotating the cameras themselves. Zoom lenses will be used to vary the distances covered by each camera.

The four cameras will each use a one-inch vidicon to transmit a 600-by-600-line picture every second. It is believed that this can be reduced in event of a power loss to one 200-by-200-line picture every 20 seconds. The cameras will also be able to look at the spacecraft itself due to the great rotation degree permitted by the mirrors. Precautions will be taken to protect the cameras from damage by direct sunlight and thermal extremes.

A telescope is also under consideration to allow long-distance viewing and also to increase resolution of short-distance viewing. The cameras will be capable of looking back at earth.

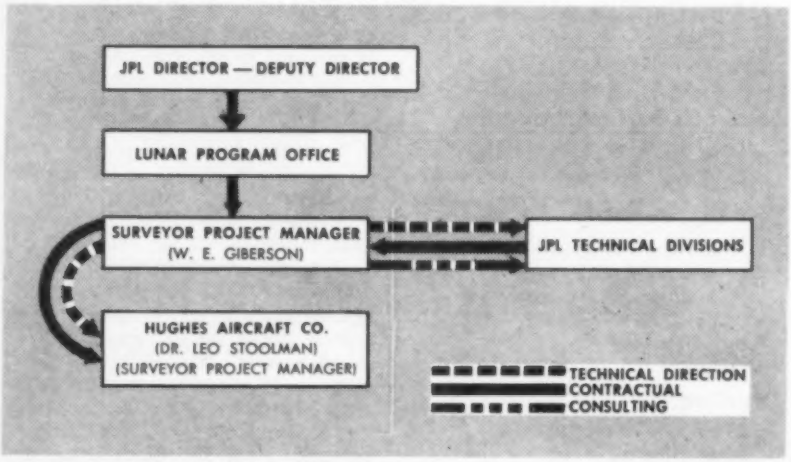
• **Drill rig**—The Hughes-developed drill will use a combination of impact and rotation to break the lunar soil and distribute it to various instruments for analysis. It will probe from 18 inches to five feet below the surface under electrical power. Findings of the analyzing instruments will be telemetered back to earth.

Certain instruments, because of their nature, will be held at "arms length" from the *Surveyor* vehicle on long telescoping booms so that the parent vehicle does not disrupt the measurements to be taken. The 15-ft. booms will hold such instruments as the ionization gage and magnetometer.

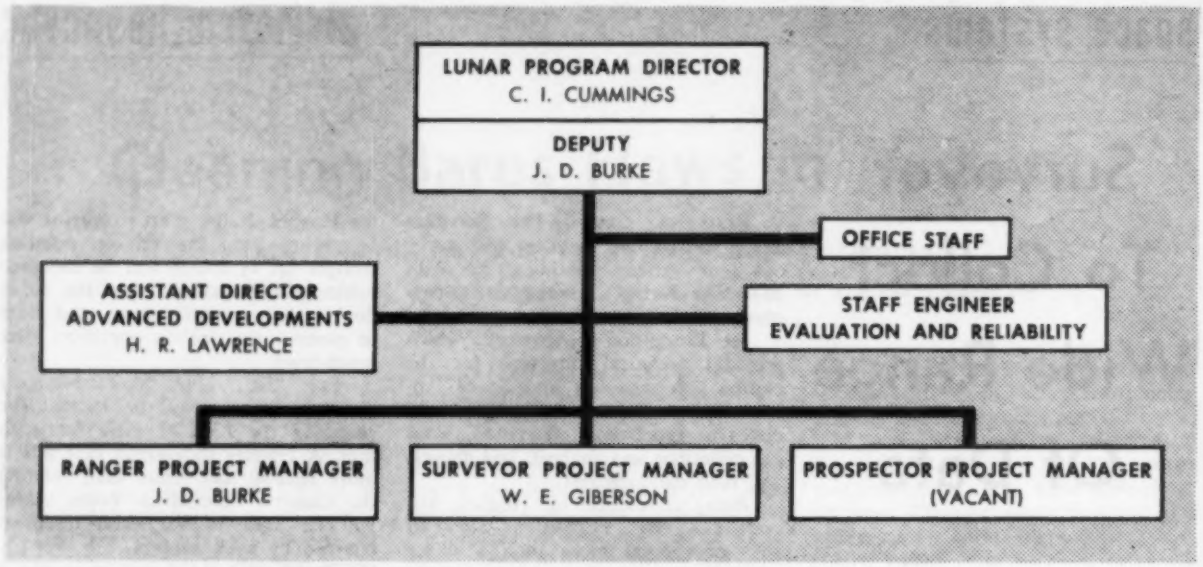
If the *Surveyor* vehicle should tip over upon landing, which is improbable, the data from these boom-borne instruments will likely be lost. But a certain amount of backup is available for other instrumentation.

Power supply will consist of storage batteries and solar cells. The solar array will be about 9 square feet and is expected to operate at a little less than 10% efficiency.

A thermal control system is included in the vehicle to keep the



JPL/INDUSTRY RELATIONSHIP for Lunar Program Using Surveyor Vehicle.



LUNAR PROGRAM OFFICE organizational chart for NASA's Jet Propulsion Laboratory.

temperature stresses within tolerable limits.

• **By the numbers**—According to JPL, the vehicle's first action on the moon will be to deploy the drill and mass spectrometer. Then it will orient the antenna and solar panel toward earth and the sun, survey the scene with its TV cameras, and deploy instrument booms and other experiments.

A one hour TV survey will be conducted soon after landing; then the cameras will be turned off while other experiments are carried out. A second TV survey will follow.

Instrumentation will be of the command type, supplemented by pre-programed types according to requirements for the experiment.

Surface chemical analysis will be carried out by a X-ray fluorescence spectrometer, a neutron activator, a mass spectrometer and a gas chromatograph for detection of organic molecules.

Surface physical analysis will be conducted by a densitometer, thermal and electrical conductivity instruments, sound speed measurements, and the television systems.

Local subsurface properties to a depth of five feet will consist of X-ray spectrometer and neutron activation instrument in the hole made by the drill, vertical temperature gradient measurements, thermal and electrical conductivity measurements, and the densitometer.

Lunar structure will be examined by a three-axis seismometer and the gravimeter.

• **Ranger bird dogs**—The 11-ft.-tall *Surveyor* vehicle will benefit somewhat from the data to be gained by its predecessor, the *Ranger* probe. *Ranger* will give JPL/NASA an indication of the range of measurement to be expected from each type of experiment, thus avoiding any waste of data because of incorrect calibration.

After injection into its lunar trajectory by the *Atlas-Centaur* fired from Atlantic Missile Range, *Surveyor* will weigh about 2500 lbs. Landed on the moon, the vehicle will weigh about 750 lbs., of which 500 lbs. will be communication equipment, structure and temperature control devices.

Contractually, JPL/NASA will handle *Surveyor* in a way different from its approach to the *Ranger* system. In *Ranger*, JPL is designing, assembling and operating the spacecraft, while using some minor subcontracts and one major subsystem contract. Aeronutronic will build the *Ranger* lunar capsule for JPL.

In *Surveyor*, however, the complete spacecraft system design and operation responsibility is being turned over to Hughes Aircraft Co. JPL will retain execution of missions including general project control, solution of interface problems, and coordination of scientific experiments from various sources.

The program beyond *Surveyor*, *Prospector*, will be handled in about the same manner. *Prospector*, a moving vehicle for lunar exploration, will be designed as much as possible to use proven hardware and techniques tested in the two preceding lunar programs.

JPL says that it may be necessary to develop a new means of locomotion for *Prospector*, as well as some special components, but that essentially the vehicle will be based on hard knowledge, rather than a list of inventions.

Funded, competitive industry studies will begin in Fiscal 1962, and JPL expects to notify industry when activity begins on *Prospector*.

In *Surveyor*, as well as *Prospector*, program management will be carried out by the project manager monitoring the prime contract, with technical assistance from the JPL technical divisions. ■

Surveyor Experiments

Surface Chemical Analysis

1. *X-Ray fluorescence spectrometer*
2. *Neutron activation techniques*
3. *Mass spectrometer*
4. *Gas chromatography*

(Detection of organic molecules)

Surface Physical Analysis

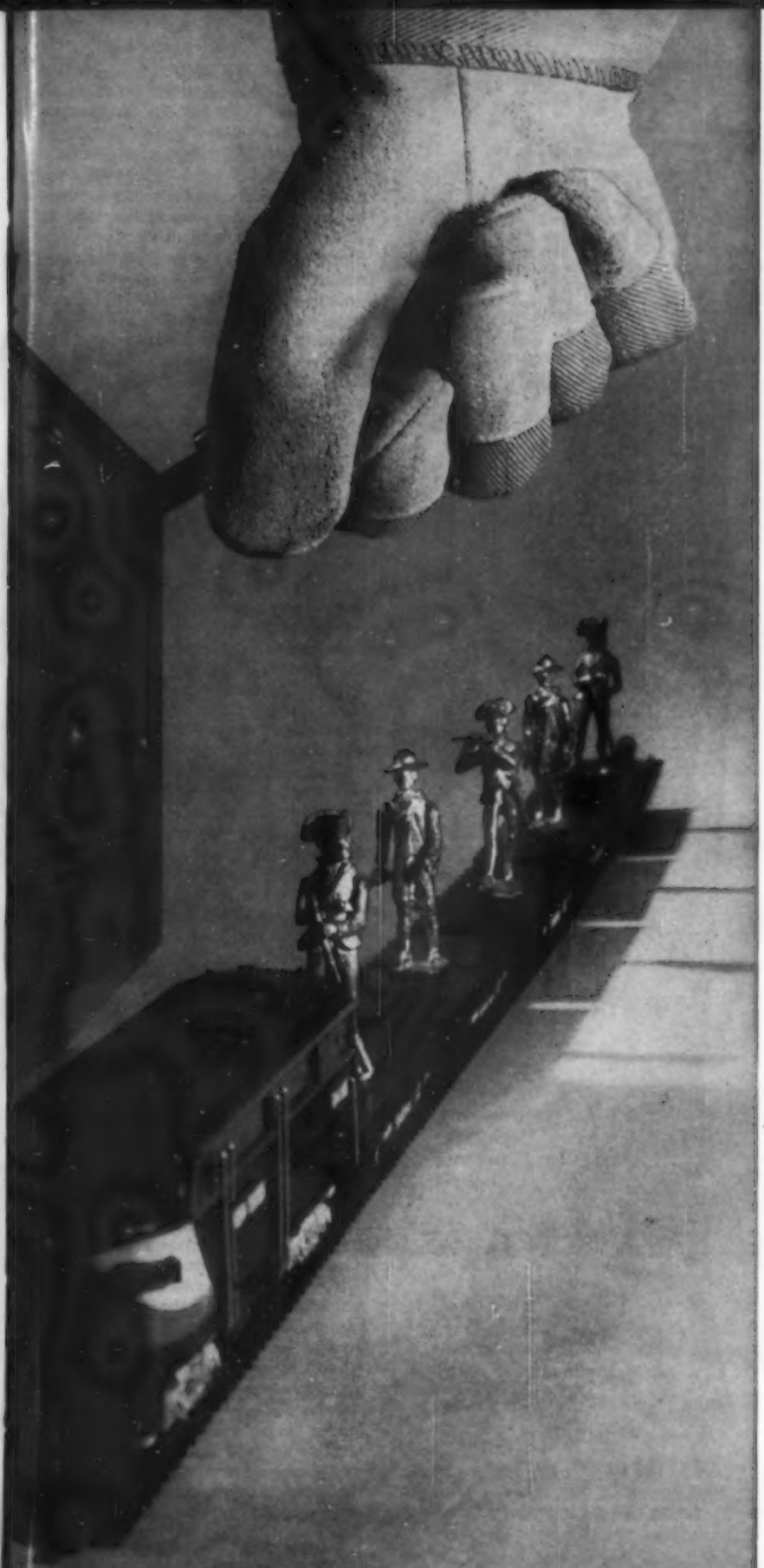
1. *Densitometer (λ-Ray Scattering)*
2. *Thermal and electrical conductivity measurements*
3. *Sound speed measurements*
4. *Vidicon with variety of magnifications*

Local Sub-Surface Properties (Drill to 4 or 5 Feet)

1. *X-Ray spectrometer and neutron activation instrument in cave-hole*
2. *Vertical temperature gradient measurement*
3. *Thermal and electrical conductivity measurements*
4. *Densitometer*

Structure

1. *Three-axis seismometer*
2. *Gravimeter*



He's got Minutemen "working on the railroad"

Hard basing is one way to protect America's force of retaliatory ICBM's. The problem was to find an alternate means of accomplishing the same mission. The Air Force solution was a new ICBM mobility concept—railroad car-mounted Minutemen, utilizing the nation's vast track mileage for numerical and geographical dispersion, creating a difficult target for enemy attack.

To put the Minuteman, its support systems and associated equipment on rails was a completely new problem in missile handling. The first requirement assigned by Boeing to American Machine & Foundry Company and ACF Industries, Inc., was a feasibility study of the existing limitations of roadbeds, rails, railroad operations and right-of-way. Unique tactical cars are being designed within these limitations to carry the Minuteman—cars that can handle the missile and its operating equipment, safely isolated from roadbed shock and ready for immediate retaliatory launching.

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How Can Pilot Best Control Ship's Attitude?

Study by Lear, Inc. tests six configurations in simulation booth to determine what degree of manned control is best, which equipment is suitable and what is lacking.

by Charles D. LaFond

SIMULATION BOOTH developed by Lear, Inc. was used to study attitude control in "manned space vehicles." View shows location of displays and right and left control consoles. Analog computer was used to provide simulated system dynamics.

THE PILOT of a spacecraft will be able to stop vehicle spin with reaction jets in 10 seconds. He'll do it with 90% efficiency in fuel use, if he has the proper displays and controls.

Lear, Inc., in a report recently presented to the Air Force, disclosed these findings from an exploratory study of "Manual Attitude Control in Space." The study is part of an overall research program, performed by Lear under an AF Flight Control Laboratory contract during the past several years, to investigate and develop cockpit and control/display requirements for manned space vehicles (M/R, Aug. 8, 1960, p. 36).

When, in the not too distant future, man flies in outer space—whether in an orbiting boost glider, aerospace plane or an interplanetary space ship—there will be many functions that he must perform or at least monitor. One of these—with certainty—will be the control of vehicle attitude.

It will be needed for antenna orientation, environmental control, maneuvering, weapons launch, navigation and observation. And especially during the unpowered portion of the flight.

To this end the present phase of the contract work is directed—to find out how attitude control will be performed, when, how well, in what time period and with what instrumentation and fuel requirements. An equally important goal is to find needs for equipment or instrumentation not yet available and to determine requirements for their eventual development.

Finally, the researchers are attempting to learn which attitude control is best: manual, fully automatic or some combination. If a combination appears best, the extent of each and override limits must be determined.

• **Six approaches**—A simulation booth, with necessary controls and displays, was employed in the experiments. Outside, an analog computer was used to provide system dynamics and a means for scoring.

The 3x5x5-ft. high booth also was provided with two-way communications. Controls and foot pedals were modified and relocated when necessary during the various tests.

Six different control configurations were examined by the researchers. Three made use of a hemispherical control knob permitting three-axis motion. A modified autopilot controller, the knob permitted both an on-off capability and a three-direction variable control—output proportional to the angular deflection. It also was spring loaded for automatic return to neutral (center) on each axis.

Of these three control configurations, two differed only in the location of the knob: one was installed on the

console to the right of the operator; the other was mounted on an armrest just above the operator's lap. With either approach, control was possible simply by wrist motion, but the armrest permitted adjustment of the unit for maximum comfort.

In the third approach, the yaw control was disconnected and tied into two foot pedals in front of the operator.

The fourth and fifth configurations employed a different controller, provided with three separate controls. Disc shaped, each was mounted on the same panel in such a way that it could be rotated about the axis corresponding to its control function—yaw, pitch, or roll. Only on-off action was provided.

Interchangeable with the hemispherical knob, the controller was installed on the right console in the fourth experiment and the foot pedals again were used for yaw control in the fifth approach.

Single disc-type controls and the foot pedals were used in the sixth control configuration. Pitch control was installed on the console to the right of the operator and roll was handled from his left. These controls too were capable only of on-off action and were spring loaded for return to neutral.

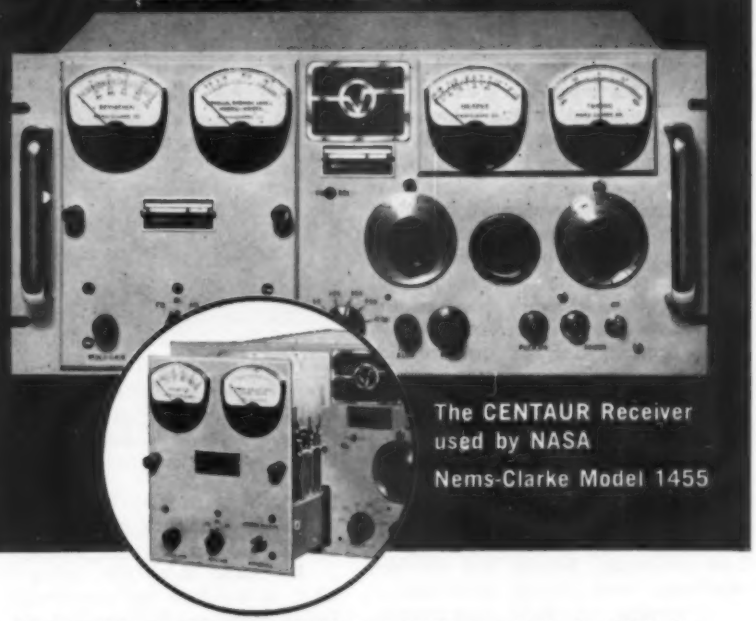
Two display configurations were examined; both employed a standard Lear moving-sphere, three-axis, attitude indicator. Modified slightly (moving bank-angle indices on the periphery of the display were masked), it showed elevation, azimuth, and roll angles continuously through all possible attitudes.

The moving-sphere indicator was used alone on the first tests; three meter-movement indicators were added for the next display configuration. These displayed angular rates for yaw, pitch and roll in degrees/second. Standard Simpson panel meters were employed having zero rate at the centers and five graduations on either side of the zero index.

• **Simulations: realistic, diversified**—Two hypothetical space vehicles were assumed in the project, one spherical with equal moments of inertia around all axes; the other non-spherical with unequal moments. Pitch and yaw moments of inertia were determined at ten times the roll value, in the latter vehicle.

As mentioned earlier, system dynamics were simulated with an analog computer. Completely undamped attitude control was provided by simulating a pair of opposing reaction jets in each of three orthogonal planes referenced to the operator's position. To simulate the lag of a typical attitude control system, controller outputs were passed through a 0.25-sec. time lag.

MODULAR TELEMETRY RECEIVER FEATURES MULTIPLE BANDWIDTH SELECTION



The CENTAUR Receiver used by NASA

Nems-Clarke Model 1455

Designed to provide a selectable bandwidth capability for PCM, the 1455 most nearly approximates a "universal" telemetry receiver. IF/Demodulator Modules are available in bandwidths ranging from 100 KC to 1.5 MC. Each module contains 3 independent demodulators. Selectable by a front panel switch, they are: Foster-Seeley Discriminator, Phase-Lock Detector, and AM envelope detector. As a further refinement in signal-to-noise ratio enhancement, the video amplifier incorporates a video bandwidth filter having a 6 db per octave roll-off adjustable from 20 KC to 1.2 MC by means of a front panel switch. This receiver is capable of **optimum** reception of any known type of telemetry signal. Features: 5 MC pre-detection recording output, playback input terminals, and integral VFO, automatically actuated by a micro-switch on the crystal socket. The modulation sensitivity and deviation meter scales provide output voltages and meter deflections which are essentially the same percentage of bandwidth in all modules.

Available as an accessory unit is the Nems-Clarke IFC 1400 Pre-Detection Converter which permits use of the 1455 with stationary-head instrumentation tape recorders for pre-detection recording.

See the 1455 Receiver at the I.R.E. Show, Booths 3917-3919.

Vitro ELECTRONICS A DIVISION OF VITRO CORPORATION OF AMERICA

PRODUCERS OF NEMS-CLARKE EQUIPMENT

919 JESUP-BLAIR DRIVE, SILVER SPRING, MARYLAND / 2301 PONTIUS AVENUE, LOS ANGELES 64, CALIFORNIA

Outputs were integrated to obtain the three body-axis rates, which were then used to position two servo-multiplier shafts for each axis. The multipliers used with integrators and summing amplifiers generated direction cosines.

With such a setup, a variety of possible experimental conditions were available; as many as practicable were used in the tests. In the static state, four different initial attitude positions were available. Selection was by a switch before the start of the particular experiment.

Any of twelve combinations of body axis rates could be preset before the trial began. When the dynamic condition was specified, two initial situations were possible; either the trial commenced with vehicle spin starting from 0°, 0°, 0° position, or the vehicle was permitted to spin for 10 sec. and attitude information was presented to the operator.

Two control systems were available: in one, the reaction jets were either fully on or fully off; in the other, thrust magnitude of the reaction jet increased as a linear function of the amount of control deflection.

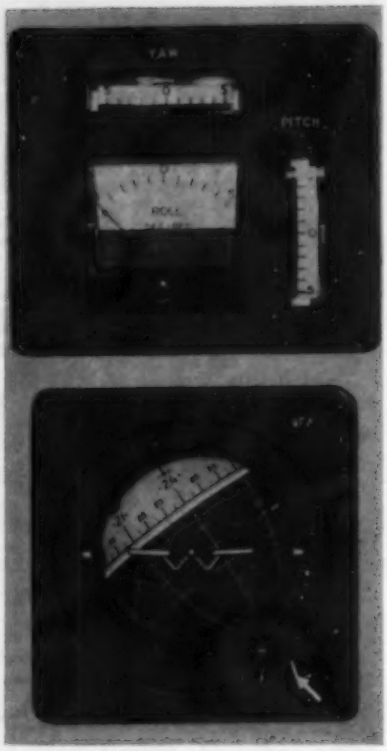
In scoring, operator performance was indicated by measuring the amounts of control action and time required to accomplish a specified task.

Male test subjects, ranging in age from 25 to 40 years were used in the simulations. Previous flying experience varied from current-jet-aircraft-operation down to no-pilot-training for six Lear personnel. Several had previous experience with aircraft simulators.

Regardless of their backgrounds, test subjects were thoroughly familiarized with the simulator and its controls by means of tape-recorded briefings, demonstrations, and a minimum of three 40-minute practice sessions each. Also, test subjects were given time to practice before each experiment, following the briefing for that test.

Twelve experiments were performed in all by each participant. An orderly variance was achieved in the twelve tests by the choice of simulated vehicle configuration and its initial position and condition, controls and display selection, and the assigned task. In all, thirty-five test conditions were achieved in the twelve experiments. Obviously more could have been obtained, but these were considered most meaningful and representative. Also, several tests were identical. This was done to check the effect of learning on the test results.

• **Control is feasible**—Lear feels that this first, not too precise, set of experiments has shown the feasibility of manually controlled attitude of space vehicles. Further, it has shown that with rate displays subjects were able to stop spins in roughly 10 seconds with a fuel-use efficiency of approximately 90%.



METER-MOVEMENT angular-rate indicators (above) and moving-sphere three-axis attitude indicator (below) comprised the display configurations examined during the twelve simulations.

But most of all this was a beginning. It has laid the groundwork for future study and has revealed the various avenues to be explored.

For example, test results indicate that the attitude displays accounted for the largest equipment effects. For the future, it is believed that more intensive investigations of display variables could provide the best payoff for the variables tested. Better displays may result from a better understanding of the contribution proffered by these components.

Another point. The issue of proportional vs. on-off controls was only slightly cleared by the limited tests. On-off controls seem to offer a small time advantage, but a slight fuel advantage resulted from the use of proportional controls. A more concentrated effort will help determine the range for each by employing more precise measurement techniques. At the present time fuel appears to be an extremely critical problem in orbit, thus even a small increase in utilization efficiency could prove to be rewarding.

Insignificant gains were revealed with the interchange of controllers and their location. However, Lear feels that only good configurations were employed, with selection based on proven apparatus and physiological necessity. This does not mean that different control-display relationships might not achieve significant improvements.

• **More answers urgent**—Only the surface has been scratched in this quest for critical knowledge. The Air Force is expected to award a follow-on contract for this research sometime in March. Besides those more advanced studies already suggested, other investigations are indicated in the Lear findings:

(1) The inputs to more sophisticated control systems should be studied. Rate indicators may be eliminated by allocating the integrations needed to the control system itself. (It was also suggested that a reaction jet which could be moved relative to the vehicle surface might increase efficiency simply by offering better alignment with the resultant motion.)

(2) Display and control design so far has been studied with respect to attitude maneuver for the control of spin. There may be other influences not so far considered which could alter equipment configurations.

(3) An alternative approach to minimum fuel consumption should be considered. Orbiting space pilots, for example, may prefer working with low rates of change and take a long time to perform a control task. This would significantly increase demands for display and control sensitivities.

(4) An intensive study of the control-display aspects and the information requirements for re-entry are mandatory.

If the present studies are continued to their logical conclusion, man in a controllable space vehicle will have the best that can be designed under our present earthbound developmental limitations. Advanced modifications, based on practical experience, still will have to come from those who have lived through such flights and returned. ⌗

UDMH 'Tagged'

Tracerlab Development Locates It in Bodies

ONE OF THE MOST toxic propellants handled by man has been given a "tag" so that physicians can trace and control its effects on those who must be exposed to it.

Tracerlab of Waltham, Mass., has completed a WADD contract for synthesizing Unsymmetrical Dimetheyl Hydrazine (UDMH) with a small amount of radioactive Carbon 14. Experimenters will thus be able to identify the compound in the user's body and gather data on its metabolic fate.

XLR99

Most powerful rocket engine ever built to the strict reliability specifications needed for manned flight...and now powering the X-15 on its record-breaking missions to the fringes of space... the pilot safe, pilot controlled XLR99 is adaptable to many aerospace programs planned for the future.

THIOKOL

Thiokol. CHEMICAL CORPORATION, BRISTOL, PENNSYLVANIA

Rocket Operations Center: Ogden, Utah. Reaction Motors Division built XLR99

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AEC Funding Cut Hits SNAP 4 Underse?o

Space power units are now getting top priority; Navy cannot show requirement

by William Beller

MONEY PROBLEMS are snagging development of SNAP 4—a 3-megawatt nuclear powerplant holding a possible high potential in antisubmarine warfare.

The Atomic Energy Commission, MISSILES AND ROCKETS has learned, is lopping $1 million from the program, reducing SNAP 4 to $600,000 in FY '62.

The cutback results from lack of a hard and fast requirement, plus DOD and NASA requests to step up development of SNAP units 10A and 8 for use in space. AEC reportedly took the $1 million from SNAP 4 when it had to find $9 million to finance the acceleration for the other two programs.

SNAP 4 appears to have run into a long-standing hassle between DOD and AEC over the AEC's demand for "specific" requirements. The policy was set forth rather pungently by former AEC Chairman John A. McCone, who had a habit of telling the military: "Now look, damn it, if you want it, say so. But, by God, if I build it for you, you better use it."

Lack of a user requirement for the 17-ton terrestrial and underwater SNAP 4 reactor was disclosed Feb. 23 during a hearing by the Joint Congressional Committee on Atomic Energy.

• **Wide ASW uses**—The hearings brought out that the SNAP 4 was stimulated by an attempt to get a powerplant small enough to be used at the bottom of the ocean and be left unattended for a year.

Dr. Chauncey Starr, president of Atomics International, prime contractor for reactor nuclear systems for auxiliary power, told the Committee that SNAP 4 could be ready for ground-testing in 1965. It could develop from one to three megawatts of electrical power; and would consist of a nuclear reactor and a power conversion unit to change the heat of the reactor into electricity.

There are many uses seen for such a unit. It conceivably could generate enough power to keep several hundred thousand square miles of ocean area under constant surveillance for a year by a network of active sonobuoys; or an area many times that size for an indefinite period by a network of passive sonobuoys.

For marine applications, two SNAP 4 units connected in parallel would give out 6000 shaft horsepower. This would be enough to drive the relatively small and cheap nuclear submarines that some Navy planners say they want. The conventional nuclear submarine needs 15,000 shaft horsepower and costs about $55-million.

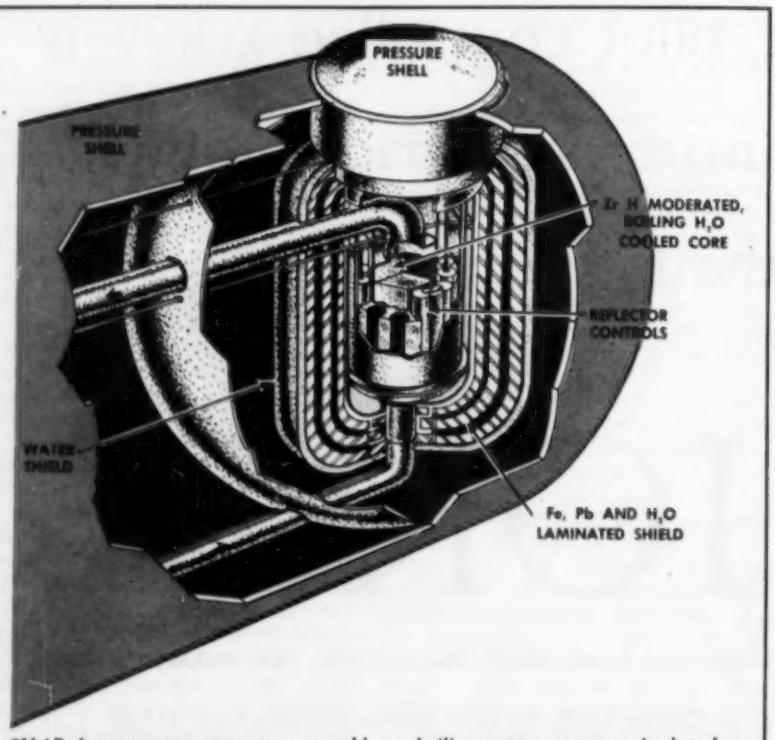
Some military observers are wondering at DOD's lack of imagination regarding SNAP 4, especially since no other power source even competitive with it is on the horizon. For example, they see versions of SNAP 4 being in stalled on torpedoes which could be strategically placed and poised for an attack.

They also see SNAP 4 being used as sustaining power in the hydrofoil fleet the Bureau of Ships is now contemplating; and for powering ocean-floor reconnaissance vehicles such as the ones being developed by Hughes Aircraft and Cook Electric.

These vehicles are expected to search the ocean floor for enemy mines, sonobuoys and other foreign bodies. Some of them will have a television camera helping. If nuclear-powered, they would be independent of cable and batteries, could be directed by sonar signals or, if a float is sent up, by radio signals from aircraft or ship.

SNAP 4 could also be used as an emergency power supply, or as an air-transportable energy source for remote areas. It could also be barge-mounted for some industrial power needs.

• **A power play**—The AEC's policy of "no specific military requirement, no money," was sharply criticized last December by the Joint Committee on Atomic Energy chairman, Representative Chet Holifield. He said, "It would seem to me that the AEC should proceed independent of a requirement from another agency if the research and development appears necessary and desirable."



SNAP 4 megawatt power source would use boiling-water reactor to feed turbo-generator. Typical 17-ton unit would be contained in 16-ft.-long cylinder.

Power Unit

Pointing a finger at DOD, Holifield observed during the hearings now going on that; "If this Committee and the AEC had stood back and waited for the Navy to make a requirement for a nuclear-powered submarine, we would not have it yet . . ."

In the present situation, the SNAP 4 program appears to be both a pawn in a struggle between DOD and the AEC concerning the requirements question; and at the same time, a wedge to force Congress to give more money to the SNAP 4 program. The importance of the project is considered high enough to bring both issues to a head.

A critic remarked during the present hearings that if nothing is done, a few years from now this Committee will be able to look back and pinpoint 1961 as the start of the "ASW Gap."

• **SNAP 4 today**—Right now, SNAP 4 is in its preliminary design stages. Next portion of the program, if it moves ahead, will be a critical experiment at the end of the year.

The turboelectric converter work has been studied in a preliminary way by several manufacturers; however, Atomics International has not yet authorized any work on it.

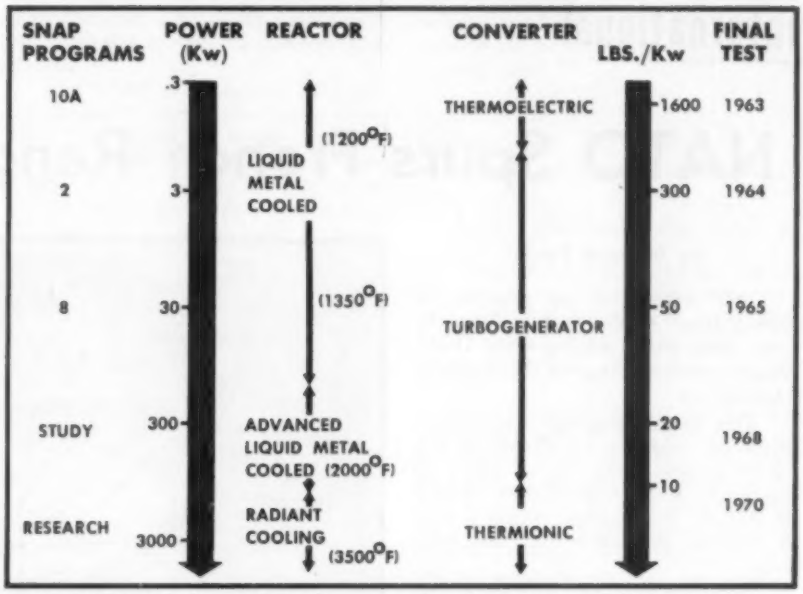
Starr said that if the SNAP 4 program is given significant support, "We would have ground test availability toward the end of calendar 1965."

• **How it works**—The SNAP 4 concept uses the conventional steam powerplant cycle—the Rankine cycle—to generate electricity. However, in the SNAP unit the heat source is in the nuclear reactor. The nuclear fuel turns the coolant water into steam, which in turn drives a compact turbogenerator.

This combination of a compact reactor and power conversion system is said to lead to a transportable, factory assembled and tested terrestrial power unit.

The SNAP 4 reactor departs from the usual boiling water reactor (BWR), where neutron moderation is done by the hydrogen in the water. In the SNAP 4, about 70% of the neutron moderation is performed by the hydrogen in the hydride fuel element.

Because of this technical difference, Atomics International reports that the power density in the SNAP 4 reactor would be six to ten times as great as that in a conventional BWR. This means that for equal power output, the SNAP 4 core volume would be only one-sixth to one-tenth that of the usual BWR.



TEST DATA and characteristics for space-oriented reactor-type SNAP units.

A typical SNAP 4 unit would weigh about 17 tons. It would be contained in a cylinder about 16 feet long and 7 feet in diameter. Illustrative of the extreme compactness of SNAP 4 is that the weight of only the containment vessel to resist a 6000-fathom water pressure would be twice that of the powerplant itself.

In a marine application, the SNAP 4 would be developing power at about 40 pounds per shaft-horsepower. This is the same as the machinery weight per shaft-horsepower for high-powered naval vessels such as cruisers, fitted with modern geared turbines.

• **Other SNAP programs**—Except for SNAP 4, the SNAP systems being developed are designed to give power chiefly under a space environment.

These sources range from a few watts of electrical power to 60 kilowatts. The power range from a few watts to several hundred is generated by units whose heat comes from the decay of radioisotopes. However, above several hundred watts, the radioisotope gives way to the nuclear reactor.

The present SNAP reactor programs for outer space applications are SNAP 10A, a 500-watt power unit; SNAP 2, a 3-kilowatt unit; and SNAP 8, a 30- to 60-kilowatt unit. For inner space or terrestrial use, the SNAP 4 program covers the power range from 1- to 3-megawatts.

An accompanying chart shows the status of the various SNAP reactor programs. SNAP 10A involves a thermoelectric converter with no moving parts. On the other hand, SNAP 2 uses a compact mercury-vapor turbogenerator as its energy converter.

The SNAP 8 reactor is a slightly enlarged version of the SNAP 2 in order to give the higher power. Thus, the SNAP 4 reactor would be able to build on the basic fuel development and control concepts of the other SNAP systems. ⌗

Navy's Giant X-Ray Ready For Big Booster Inspection

A TEN-MILLION-VOLT X-ray inspection unit will be probing *Polaris*, *Minuteman* and *Skybolt* solid motors for flaws, cracks and voids at the U.S. Naval Ammunition Depot, Concord, Calif.

The radiographic linear accelerator was designed, built and installed by Varian Associates, Palo Alto, Calif. The X-ray head can be rotated 360° in a vertical plane. The linac is mounted on a turntable which rotates 360° in a horizontal plane and is suspended from a telescoping crane.

A powerful electron gun bombards a gold target which emits X-rays so powerful they can radiograph a five-foot-thick section of fuel in a matter of minutes.

Flaws down to a few hundredths of an inch in diameter can be detected on the films produced by the instrument.

Shakedown tests have been completed and the new machine is ready for production operation. The Depot has two two-million-volt inspection units and the large Varian Linac will reduce the time and cost of inspecting large motors to approximately a fourth of that required for these units. ⌗

NATO Spurs French Range Expansion

by Bernard Poirier

THE FRENCH are planning to extend their African missile range by some 2000 miles, making it the West's longest overland range in the Northern Hemisphere.

This range, together with others proposed, would enable France to step up its present firing rate of about 30 missiles a week from Colomb-Béchar in Algeria. New ranges would extend in different directions from the same area.

New construction of launching, storage and telemetering facilities has already been authorized. SETEL has selected this site for NATO *Hawk* evaluation and assurance flight tests.

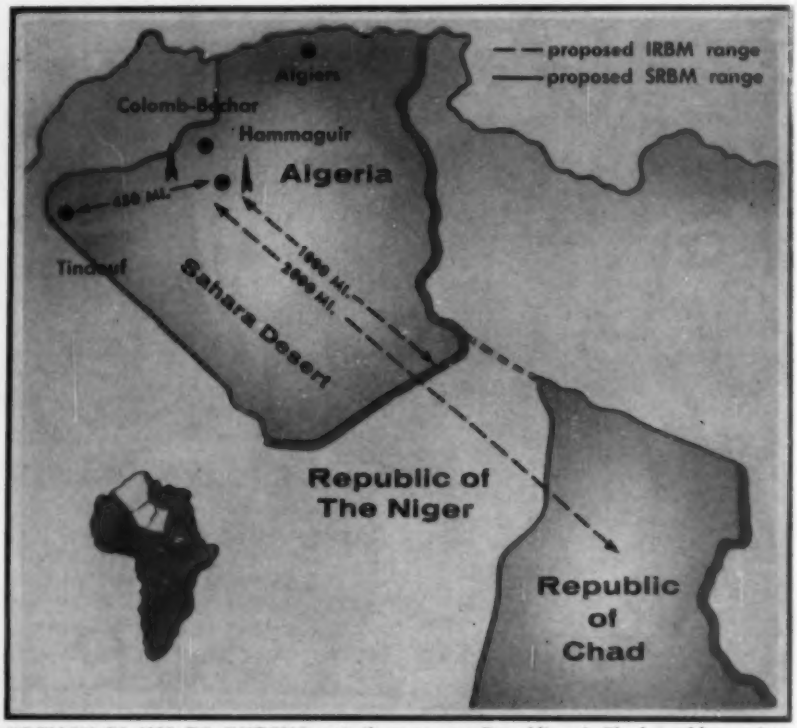
Colomb-Béchar is usually identified as the major French missile test center, but the actual center of activity is Air Force Base No. 145, located nearby. An 80-square-mile range just northeast of No. 145, Range B-1, is used for air-to-air and air-to-surface tests. It is close to the Moroccan border in rugged, uninhabited terrain. Larger vehicles are usually launched 70 miles southwest. It is at Hammaguir that French scientists pin their hopes for serviceable SRBM and IRBM ranges.

It has been found that spent vehicles and instrumented packages can be recovered quite simply and reliably on the adjoining empty plateau.

• **Expansion plans**—So far, the operating area has been confined to a strip 60 miles by 35 miles. Current plans would extend one arm of the range 450 miles southwest towards Tindouf and the Mauritanian border. Another firing corridor, southeast, would extend close to 2000 miles—from Hammaguir, over Algeria and Niger, to the midlands of Chad, once part of French Equatorial Africa.

Expansion of electronic measuring and tracking inventory is being undertaken. Much of the existing equipment, such as Cotal radar, is mobile and most of the aprons accommodate mobile launchers and peripheral units.

Technical management of all Algerian missile operations is provided by C.I.E.E.S., Le Centre Interarmées d'Essais d'Engins Spéciaux. The Army plays the most important role, followed closely by the Air Force. While the Navy does have representation, it has its own test site on Levant Island.



FRENCH PLANS TO EXTEND missile range to Republic of Chad could run into difficulty if there are objections from neighboring Republic of the Niger, whose territory would be overflown. Expansion would require additional tracking stations.

Representatives of the nationalized military propellant industry and C.N.E.T. (National Bureau for Communications) are stationed there. So are many civilian technicians from organizations like DEFA, makers of the *Véronique* and *Parca*.

Despite excellent air transport routes, however, autonomous operations are hampered because the useable computers are located in France proper. For instance, telemetering data is collected on rapid magnetic tape, at the rate of 1050 bits per second, and the tapes are then sent to Bretigny for deciphering and analysis.

• **Speed-up coming**—The French will soon step up action in response to NATO interest The base reports that NATO's *Hawk* prime, SETEL (Société Européenne de Téléguidage) has already initiated administrative and engineering activities through personnel of Thomson-Houston Co. of France.

Moreover, missile capabilities of the new Mirage III and Mirage IV strike force aircraft (M/R, Feb. 6, p. 40) will be proven here. Expansion plans are also necessary to accommodate the *Super-Véronique* and another research rocket being manufactured by Sud-Aviation. Other missiles, including the advanced *Parca* version, require longer working areas.

New tracking stations will have to be installed well beyond those at Poste 22 and at Beni Abbès.

The whole North African range has two important natural advantages. Arid, flat and mostly uninhabited land assures security. Secondly, the very dry air facilitates accurate optical tracking operations.

From the first launching in December, 1949, the number of firings increased to 800 in 1958 and to 1250 the following year. Approximately 5000 persons are stationed or employed at the various complexes which comprise the Colomb-Béchar establishment. In addition, the French Army maintains two full strength missile weapons units in training at all time. ⌗

Booster Breakthrough?

(Continued from Page 13)

If the big solid were substituted for *Saturn* as a booster, some additional money would be involved, of course, to build a vehicle around it. The latter money need not be spent, unless it becomes apparent that *Saturn* is slipping badly. The big liquid-propelled rocket is due for flight test with three live stages in 1963. First operational *Saturn* is to be launched in late 1964 or 1965.

The more likely application would be as propulsion unit for the *Nova* vehicle. Whatever form of propulsion is used for the manned lunar flight, there is high probability there will be need for a big booster, built by clustering several engines of F-1 size.

• **High thrust**—A solid rocket, which normally does not burn more than 60 or 70 seconds, would have almost twice the takeoff thrust of *Saturn* or F-1 in doing the same work. Thrust would be in the range of 2½ to 3 million lbs. However, if burning time were just half of the *Saturn* booster's 128 seconds, the solid rocket would not have to quite double *Saturn's* 1½ million lbs. thrust.

The reason for the latter saving is the advantage of the high-thrust solid in gravity loss. A big liquid weighing about 1 million lbs., which takes off with 1½ million lbs. thrust, has a net upward force of about ½ g. This gradually increases, of course, as propellant is consumed. The solid, with takeoff thrust of almost 3 million lbs., has a net upward force of almost 2g.

The net force of the solid motor also increases gradually until, at burnout, its net force is about the same as the burnout force of the 1½-million-lb.-thrust liquid booster. Thus it is clear the solid has lost less to gravity than the low-thrust liquid, even though both have the same total impulse.

Industry groups have been working for both the National Aeronautics and Space Administration and the Air Force on study and feasibility contracts in the area of big solid boosters since 1959. Currently, the Air Force has a program under way with Aerojet-General Corp. and NASA has just completed one with United Technology Corp. In addition, NASA studies are nearing completion at Aerojet, Thiokol and Grand Central Rocket Co.

Top Air Force R&D officials have indicated they believe one more interim step is necessary before a big solid rocket is built. NASA Deputy Administrator Hugh L. Dryden voiced somewhat similar views before the House Space Committee last month when he said a big solid could never be developed in time to compete with *Saturn*.

The NASA program calls for building a single segment weighing about 60,000 or 70,000 lbs. in the next year, as a demonstration that solids have "come of age." None of the technical people believe the 60,000-lbs. segment development is necessary for technical reasons.

• **Feasible now**—Skipping the 60,000-lb.-segment interim step would save a year of time. It would also save the cost—estimated at about $3 million—of developing and testing the segment. It would require, however, an immediate appropriation of $10 million.

William Cohen, NASA chief of solid rockets, reports that studies near completion by Aerojet, Grand Central and Thiokol all conclude that a big booster of 180 million pound-seconds impulse is feasible now. All find that the rocket can be built with existing propellants and inert materials. "The greater size will be the only extension of the state of the art," he said.

Cohen, who was chief propulsion engineer on the Navy's *Polaris* program from its start until about six months ago, said he is convinced that the big rocket can be developed in 30 months' time. He estimated that development can be completed with 7 to 10 full static firings.

The three NASA studies, with total cost of $225,000, covered solid boosters for two missions—the approximate *Saturn* mission of 40,000 lbs. to a 300-mile orbit and the manned lunar mission of 120,000 lbs. to escape velocity. Aerojet is studying both missions while Grand Central is working on the smaller one and Thiokol on the bigger one.

For the smaller motor, Cohen said, the consensus is a stage weighing about ½ million lbs., from 60 to 70 ft. long, with a diameter of 12 to 14 feet. If the segmented approach is used, he said, individual segments would weigh about 100,000 lbs.

The first step in the development program would be to build a single segment of about 100,000 lbs., to test physical and ballistic properties and insulation. When the segment is proved out, several segments then would be put together and fired to test the nozzle and vector control system.

If a major R&D program on a solid motor were started, Cohen said, it would be directed by NASA's Marshall Space Flight Center at Huntsville, Ala. "They have a world of propulsion skill," he remarked.

He said liquid upper stages are contemplated for any launch vehicles based on solid boosters. However, the upper stages designed for *Saturn* could not be adapted to a solid booster without modification. Tankage would have to be increased to provide longer burning time. ⌗

Dyna-Soar 3rd Stage

(Continued from Page 12)

third stage independently of the rest of the system, and be carried to an altitude sufficient for him to take over aerodynamic control of the craft and either crash-land or eject from the vehicle.

Reports indicate a glass case has the inside track with Boeing, partly due to the success of the third stage *Minuteman* case. Glass has been proposed as case material by at least two bidders, Rocketdyne and Hercules, and possibly Allison Division of General Motors, which would supply cases to another contractor for propellant loading.

If it were not for the weight consideration, one source said, the present second stage of *Minuteman* would be modified. If a metal case is chosen for the final item, weight saving steps may be taken which are not now standard in the *Minuteman* configuration. These would include modification of the aft dome configuration, closure bolting flanges, and other inert parts.

The nozzles themselves will not be the same as those on *Minuteman*. Volume capacity of the motor is about 72,000 cubic inches, in a case between three and four feet diameter by slightly less than five feet long. Wall thickness of the case may vary, depending on the successful bidder and case material chosen.

An informed source said it is unlikely a titanium case will be chosen, because "Boeing doesn't want to gamble," and it is not as light as glass.

• **Glass problems**—The propellant will very likely differ from that used in *Minuteman*, and will have to be capable of withstanding considerable temperature variation to perform successfully from sea level to extreme altitudes. Use of a glass case also demands propellant flexibility, because glass stretches three times as much as steel under combustion pressures.

Those contractors planning to use glass feel that a pre-impregnated glass roving presents the best approach. Glass cases proposed incorporate the largest ratio of end openings ever fabricated for stress levels over 100,000 psi. A 70% opening is specified for the large nozzle end of the case, while the forward end has an "extremely small" opening. Nozzles will use attachments, rather than being integrally wound into the case. ⌗

RUSSIA'S ROCKETS AND MISSILES. Dr. Albert Parry. Doubleday & Co., Inc., Garden City, N.Y. 382 pp., $4.95.

In the late 1940's Leslie C. Stevens, the U.S. Naval Attaché in Moscow, read and marveled at the 10th edition of a Soviet book that belonged to the space-prophet school of literature. The book was more than 15 years old.

"Interplanetary travel is just the thing to catch the Russian imagination," Stevens wrote. "There is an excellent chance that the Russian engineers, who do not lack for brains, will pioneer in this field."

Dr. Albert Parry, professor of Russian studies at Colgate University and a noted student of Soviet scientific affairs, recalls Stevens' words in his highly penetrating and fascinating survey of Russian efforts in the missile and space field. He begins before the days of Peter the Great in the 17th Century. He naturally ends with the great Soviet *Sputniks*. Along the way, he presents one of the most incisive explanations of how the Russian rocketry accomplished its astonishing successes.

The first Russian writing on war rockets has been traced to 1607, about the time of the first English settlement at Jamestown. A master of gunnery named Onisim Mikhailov proposed the development of rockets that would be "cannon balls that run and fly."

From Mikhailov, Parry traces the works and frustrations of Russian rocket pioneers to Tsiolkovsky in the 19th and 20th Century, to the great brain-picking of German rocket experts immediately after World War II, to the present day. He also digs deeper, probing the Soviet psyche.

At one point Parry writes:

". . . as a people Russians have for centuries been miserable and restless enough to want to escape their part of the globe in any direction whatever. They are the earth's only folk who years back coined the bitter saying—'From a good life you won't fly up'!"

The heart of Parry's book is its chapters on the Russians' current missile and space programs. He describes the Soviet missile arsenal in great detail. He gives similar treatment to the huge Soviet space boosters, their satellites and spacecraft and their scientific accomplishments in space.

This information can be regarded as highly authoritative. Parry, who came to the United States from his native Russia in 1921, has always been a wide reader of Soviet scientific and other publications and a compiler of bits of information disclosed in them. By this method over the years he has been able solely from published Soviet sources to put together the full picture of Russian rocketry presented in his book. In effect, Parry has conducted one of the most impressive one-man intelligence operations in the world.

Parry's book contains a few factual errors about American missilery. However, these for the most part can be attributed to the long lead-time perils of publication that confront an author writing about a rapidly changing field. They in no way should call into question other material in the book. This would be only a comfortable excuse to hide from the facts of Soviet progress.

Parry, speaking as an educator as well as an expert on Soviet affairs, states the meaning of those facts in blunt terms:

". . . a good idea if not active enough can be crowded off the world's stage by a bad idea that is on the march. Very sadly, there can be a kind of Gresham's Law in the history of ideas and of ways of life, too."

—J.B.

AN ENGINEERING APPROACH TO GYROSCOPIC INSTRUMENTS. Elliott J. Siff, M.S., and Claude L. Emmerich, D.Sc. Robt. Speller & Sons. 120 pp., $7.50.

In the words of the authors, this book is intended to fill the gap between the most elementary ad hoc explanations of gyroscopic effects and the complicated purely mathematic derivations associated with gyroscopic motion.

The book begins with a basic description of gyro characteristics and, with a minimum of mathematics, shows the design engineer how to apply these characteristics to new gyro problems. It attemps to strip some of the mystery from gyro design with relatively simple explanations of gyroscopics, Coriolis accelerations, and Schuler tuning. Finally, it describes some of the newest exotic designs —air bearings, electrostratic and electromagnetic suspension, vibrating gyros, and particle (nuclear spin) gyros—as well as many current applications.

Dr. C. S. Draper, in his foreword to the book, says it is "an effective effort to bring together the available information on gyroscopic devices as essential elements in an important and rapidly developing region of technology."

HUMAN ENGINEERING TESTING AND MALFUNCTION DATA COLLECTION IN WEAPON SYSTEM TEST PROGRAMS, A. Shapero and others, Stanford Research Institute, and C. Bates, Jr., Aerospace Medical Lab. for WADC. Order PB 161 832 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 52 pp., $1.25.

An analysis of the practices followed in nine Air Force missile system operations has led to the development of a recommended program for testing the performance of a system's operations.

Recommended procedures for performance testing include these steps: identifying and selecting the system's critical human operations; specifying the pertinent parameters of these operations; predicting the values these parameters will assume; confirming the predicted values through test.

The recommended method for data collection on human initiated malfunctions is based on two techniques: identification of the specific operation during which a malfunction is discovered; and the systematic collection of data on human-initiated malfunctions, even where no equipment breakdown is involved.

PERFORMANCE CHARTS FOR MULTI-STAGE ROCKET BOOSTERS, John S. MacKay and Richard J. Weber. Order NASA Technical Note D-582 from National Aeronautics and Space Administration, Washington 25, D.C. 90 pp., $2.25.

Charts are presented of the stage propellant fractions of multi-stage chemically fueled rocket-booster vehicles.

Various stage combinations of RP-liquid-oxygen and hydrogen-liquid oxygen propellants are assumed, but the results may be modified for other specific-impulse combinations with little error.

The data are applicable to both orbital and escape missions. Examples are given to illustrate how the charts may be used to determine optimum staging and thrust-weight ratios.

SEMICONDUCTORS AND TRANSISTORS, by Dr. Alexander Schure. John F. Rider, New York. 144 pp., $2.90 (soft cover).

Another volume in Rider's Electronic Technology Series, this discusses and evaluates the theory and characteristics of semiconductors and transistors.

Coverage includes the basics of atomic structure, quantum theory, conductors, insulators, and semiconductors. Conduction by holes, semiconductors with impurities, and the semiconductor rectifier are analyzed. The p-n junction under equilibrium conditions and in reverse and forward bias, diode tubes (including photodiodes), and an extension of p-n junction theory into the transistor are covered. Considerable attention is given to basic design procedures in transistor amplifiers. Review questions are included at the end of each chapter.

BASIC TRANSISTORS—Dr. Alexander Schure. John F. Rider, New York. 152 pp., $3.95 (soft cover).

A comprehensive, but basic, coverage of the transistor: what it is, what it's made of, its unique characteristics, and how it differs from the vacuum tube.

The book opens with a discussion of atoms and semiconductors and then analyzes the basic p-n junction diode. Basic transistor circuits and their action are described and analyzed.

Coverage includes transistor biasing, transistor characteristics, conventional and power transistors, amplifiers and oscillators, and tetrode units. Review questions are included at the end of each section.

names in the news

ROBERTS

BISCHOFF

HEALEY

LOBB

FERRI

Dr. Edward Teller and **Dr. Joseph Kaplan:** Internationally known scientists and professors of physics at University of California, named senior technical advisors of Geophysics Corporation of America.

Dan A. Kimball: President of Aerojet-General Corporation, received Navy Distinguished Public Service Award for foresight leading to outstanding production capability of solid-propellant motors for *Polaris* fleet ballistic missiles.

Al White: Named chief test pilot of North American Aviation's Los Angeles Division. A veteran test pilot and engineer, he will continue as project pilot on the Air Force's 2000-mph B-70 bomber, which he has been assigned to fly for the first time in late 1962. **Scott Crossfield:** Former chief test pilot, transferred to space and information systems division to head a new engineering branch to test manned space systems. With North American since 1955, he was the first to fly the *X-15*. In new position, will supervise flight test program of Air Force *GAM-77 Hound Dog* missile, as well as help develop new manned spacecraft.

Hervey J. Finison: Appointed to new post of director-business planning and development for Raytheon Company's electronic components and devices group. **E. Nevin Kather** succeeds Finison as general manager of the semiconductor division. **Edward L. Dashefsky** promoted to general manager of the microwave and power tube division, and **Joseph F. Alibrandi** named manager of the Lowell, Mass. plant of the aero/weapons division.

Stuart G. McGriff: Appointed assistant director of research and manager of the Washington, D.C. office of Ionics, Incorporated. Prior to joining Ionics, he was product manager for fuels and propellants for Callery Chemical Company.

James F. Healey: Appointed general manager of Minneapolis-Honeywell's Aeronautical Division facility, St. Petersburg, Fla., succeeding **John W. Anderson,** who is taking leave for advanced university studies.

Dr. R. Kenneth Lobb: Former head of the aerodynamics department at the Naval Ordnance Laboratory, Silver Spring, Md., named program chief for aeroballistics. He replaces **Dr. Robert E. Wilson,** who was recently named associate director for aeroballistics.

Recognition for Raborn

Vice Admiral William F. Raborn, Director of Special Projects, Department of the Navy, received the National Aviation Club's Award for Achievement in recognition of his leadership in development of the Fleet Ballistic Missile Polaris, which became operational three years ahead of the target date.

John L. Roberts: Named manager of the space technology division, Quantatron, Inc., Santa Monica, Calif. Will be responsible for the coordination of a scientific team studying the problems of space vehicle systems and developing "hardware" to support requirements of such systems.

Dr. Adolph K. Thiel: Director of space systems program management and acting director of the new fabrication, integration and test division; **Dr. Robert R. Bennett,** program director for the *Minuteman* weapon system; and **Dr. W. S. Carlson,** director of electromagnetic systems division; all named vice presidents at Space Technology Laboratories, Canoga Park, Calif.

Dr. Manfred Mannheimer: Noted for his work in the physical sciences, joins the Systems Research Center of Lockheed Electronics Co., Bedminster, N.J., to engage in projects involving propagation, nuclear fusion and re-entry.

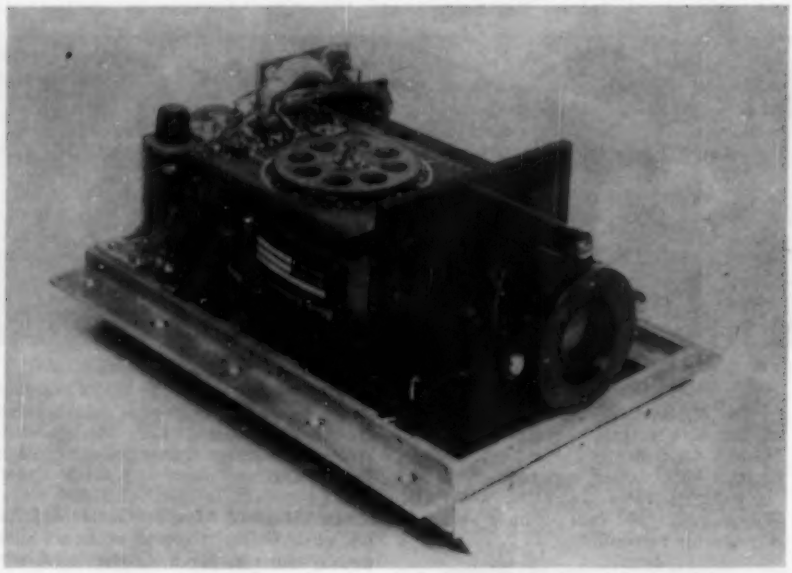
Jack T. Wills: Named to Aerojet-General Corporation's Washington staff as director of corporate special projects. **L. Wayne Mullane,** manager of Aerojet-General's Downey, Calif., plant since its acquisition from Rheem Manufacturing Co. in June, 1959, elected vice president.

Frank W. Lehan: Elected executive vice president of Space Electronics Corporation. Former director of the electronics laboratory at Space Technology Laboratories, Inc., he has been vice president of SEC since 1958.

B. E. Stitt: Appointed chief project engineer-*Nike* systems for the Douglas Aircraft Company, Santa Monica, Calif. With Douglas since 1951, he participated in the first *Nike-Ajax* and *Nike-Hercules* firings. **G. F. Hanson** will replace Stitt as head of the company's space activities at Cape Canaveral. **W. L. Duval,** appointed assistant chief engineer for missiles and space field operations, was Douglas' first field station manager at both White Sands and Cape Canaveral.

Dr. Antonio Ferri: Elected president of General Applied Science Laboratories, Inc., Westbury, N.Y., succeeding **Edward Weitzen,** who resigned to become executive vice president of Electronic Teaching Laboratories of Washington, D.C. Weitzen remains a director of GASL. Dr. Ferri was one of the founders of the company.

R. E. Bischoff: Manager-Detection and Surveillance Products Sales for General Electric's Light Military Electronic Department, has been named general chairman of the Seventh National Communications Symposium, sponsored by the Institute of Radio Engineers Professional Group on Communications Systems.



Infrared Grating Spectrometer

A small, rugged, lightweight infrared grating spectrometer is available from Block Associates, Inc. The Grating Spectrometer will scan the spectral range of 1.5 to 4.5 microns in 3.0 seconds with a resolution better than 0.1 micron.

Other spectral regions may be selected to suit the application. The electrical output of the instrument is commutated so that information related to the analysis of the spectral radiation—internal calibration, chopper temperature, amplifier zero, detector temperature, etc.—may be observed between spectral scans. This feature is especially useful for telemetry from remote field installations.

The performance of the Grating Spectrometer is virtually unaffected by severe vibration or accelerations to 15 g's.

Circle No. 225 on Subscriber Service Card.

Telemetering Accelerometer

A miniature telemetering accelerometer is available from Giannini Controls Corp. The Model 24155 weighs less than 2.5 ounces, occupies 1 cubic inch, and operates with linearity and repeatability of ±1% and hysteresis of 1%. Available in resistance ranges from 2000 to 5000 ohms yielding a 0.5% resolution, the accelerometer is supplied in ranges from ±2 g to ±25 g at natural frequencies from approximately 20 to 70 cps. Range can be extended to +100 g with natural frequency of 145 cps, and switch output can be provided in place of potentiometric output.

Circle No. 226 on Subscriber Service Card.

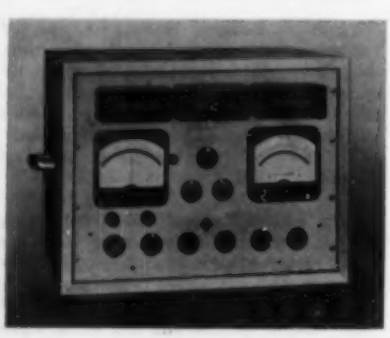
High MEGOHM Bridges

Mid-Eastern Electronics, Inc., is marketing the Model 801 and Model 802 Bridges, both designed for accurate measurement in the ultra high resistance ranges.

The Model 801 Bridge is a self-contained unit complete with built-in battery power supply (0=250 volts DC), electrometer amplifier galvanometer and nine plug-in ratio arms. No auxiliary equipment is necessary and the bridge can be made ready for operation in only ten seconds.

The Model 802 Bridge is identical to the Model 801 throughout, except that a 100 meg decade (ten steps-10 megohms/step) is included, and the 100 ohm decade of the 801 is omitted.

Circle No. 227 on Subscriber Service Card.



Low Temp Fluxless Solder

A low temperature fluxless solder, TIN-A-LUM, which eliminates the danger of metal destruction under heat is available from Metals For Industry Inc.

TIN-A-LUM joins any dissimilar metal together and can be used on all kinds of materials with the aid of a soldering iron or a light flame and without any flux whatsoever. This solder has proven to be of such tensile strength that it can even replace welding or brazing in many instances and at very much lower cost and less time.

Circle No. 228 on Subscriber Service Card.

Sub-Carrier Oscillator

PACE Engineering Co. is marketing their Model CT10 Telemetering Sub-carrier Oscillator System, providing a compact and reliable telemetering unit for operation with up to 12 variable inductance transducers.

The instrument's module case accepts six printed circuit Sub-Carrier Oscillator cards, which together with appropriate transducers may be tuned to any of the IRIG bands, 4 through 18 or optional bands, A through E. Included, also, is a Dual Channel Composite Amplifier that receives the summed output frequencies from the Inductance Oscillators and feeds the transmitter.

PACE Model CT10 Telemetering Sub-Carrier Oscillator Systems are available for operation on any specified voltage, and have frequency stability of ±1% of the bandwidth for ±5% change in operating voltage.

Circle No. 229 on Subscriber Service Card.

Micro-miniature Capacitor

A line of micro-miniature tantalum capacitors is available from Components, Inc. The capacitors are the smallest non-polar solid tantalum capacitors made that are stable over a wide range of frequencies and temperatures. The units are available in production quantities in a range of values from 0.001 to 0.0047 MFD which operate at 50 VNP and from 0.0068 to 0.047 MFD at lower voltages. They operate at full-rated voltage from −55°C to +85°C.

Circle No. 230 on Subscriber Service Card.

Tape Recorder Analyzer

Telemetrics, Inc. has packaged into a single unit a solid state analyzer for rapid and complete checkout of any digital tape recorder.

The self-contained unit is capable

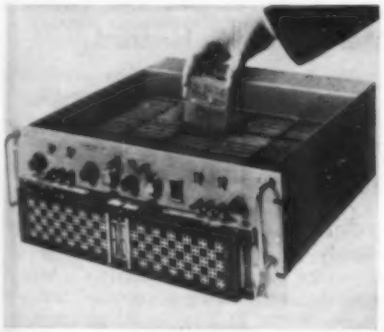
of performing all fundamental measurements to determine operational status of a recorder. The unit employs techniques to measure start and stop distances, dynamic skew, and dynamic speed variation appearing as wow and flutter.

Accuracies for distance measurements are 0.01 inches resolution to 0.003 inches; skew measurement: 2% at 1 volt peak per microsecond. Speed variations are 1% on 100 microsecond range, 0.2% on ranges of 3, 30, and 200 milliseconds, and 1 second.

Circle No. 231 on Subscriber Service Card.

PAM & PDM Simulators

Telemetrics, Inc. has available a 300 Series of solid state Electronic Signal Simulators providing a selection of PAM, PAM-NRZ, and PDM units with extreme flexibility to match ever-changing operational requirements in their many applications.



The 300 Series includes units with 8-channels of subcommutation. Other channels can be added through patching, by counts of one, two channels per frame up to 1054 per frame. Complete flexibility in patching combinations provides for location of any number of missing reference pulses and dynamic pulses in the frame.

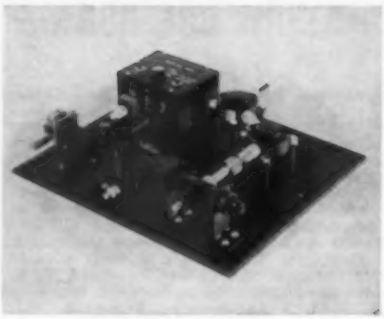
Circle No. 232 on Subscriber Service Card.

Rubidium Frequency Standard

The Rubidium Frequency Standard, a readily portable, independent atomic frequency standard, will be available from Space Technology Laboratories, Inc. in April. It weighs 20 lbs., displaces 1.6 ft³ and is unaffected by terrestrial or space environmental conditions expected to be encountered in its normal operation.

Atomic resonance, recognized as the most stable frequency base, is the fundamental principle of the device. The basic frequency reference is an optically pumped rubidium cell. Output frequencies are 5 and 1 megacycles; and 100 kilocycles.

Circle No. 233 on Subscriber Service Card.



Four Band Paramps

Low noise, stable, environmentally qualified parametric amplifiers for L, S, C and X-bands are available from Hughes Aircraft Co. components division.

One model is an S-band non-degenerate model with a noise figure of less than 3 db including circulator loss from −10° to 70°C.

The firm has measured noise figures as low as 1.9 db at S-band in their laboratory with bandwidths in excess of 80 mc at 15 db gain. Each parametric amplifier includes a basic amplifier body, a varactor diode, a circulator, pump power monitor, and a klystron.

Circle No. 234 on Subscriber Service Card.

Thermoelectric Kit

General Thermoelectric Corp. has available a Type 300 Thermoelectric Experimental Kit designed for electronic, industrial, medical and educational organizations. This kit makes it possible to obtain empirical knowledge directly of thermoelectric materials, principles and techniques in a planned and organized manner.

Circle No. 235 on Subscriber Service Card.

Solid State Power Supply

Philbrick Researches, Inc., has available an all solid state Dual Power Supply for energizing transistorized electronic equipment. Designed to take full advantage of semiconductor components, the Model 6033 Power Supply operates from 115 vac and provides 2 fixed voltage outputs: ±15 volts dc, each at 200 ma.

The Supply is not damaged even by a prolonged short circuit, because short circuit current is always less than full load. When one-half of the supply is shorted, the voltage of the other half falls well below 15v, and no fuses or breakers are needed.

Circle No. 236 on Subscriber Service Card.

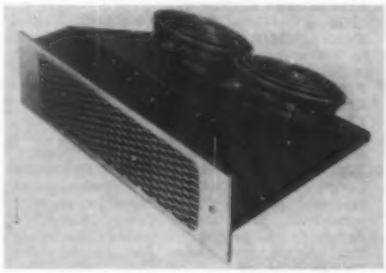
Improved Tantalum Powder

A tantalum powder to improve the fabrication and performance of electrolytic capacitors is now available from the Metals Division of National Research Corp. The SGP powder enables pellets to be pressed to lower green densities, lowering dissipation and increasing capacitance per gram. At the same time, the product retains the outstanding electrical properties and high chemical purity of the company's SGN powder.

Circle No. 237 on Subscriber Service Card.

Cabinet Flushing Fans

Twinpax, a new concept in cabinet flushing fans, are available from Rotron Manufacturing Co., Inc. The two fans working in parallel produce a delivery of 450 cfm free delivery, or 400 cfm at 0.1 in. wg static pressure,—when operating on either 208 vac 60cps 3 Ø or 115 vac 60cps 1 Ø power. The fans are placed at an angle in the assembly, thereby directing the air flow at the most advantageous path minimizing "dead spots" and eddying within the cabinet.



Circle No. 238 on Subscriber Service Card.

Radar Beacon Checkout

Astronautics, Inc. is marketing a radar beacon checkout unit. Model RBCC-1 is designed for multiple functions in relation to a C-Band beacon. Included are the following parameters: threshold, power output, countdown and beacon delay and repeater if required. Comparable units are available for each of the various bands.

The RBCC-1 is designed for mean operation at 5600 MC, although the unit is available in ranges from 1 KMC to 12 KMC operation. Test time with the RBCC-1 including set-up and calibration does not exceed 45 seconds.

Circle No. 239 on Subscriber Service Card.

contracts

NASA

$250,000—**Lear, Inc.**, for studies on Project *Apollo*. Subcontract from **General Electric's Missile and Space Vehicle Dept.**, Grand Rapids, Mich.

MISCELLANEOUS

The Garrett Corporation's AiResearch Manufacturing Co. Los Angeles, awarded 3-year contract by **North American Aviation's Space and Information System Division** for study of requirements, design concepts, and integration of environmental control systems for future space vehicles. No amount disclosed.

Douglas Aircraft Company, Santa Monica, Calif., with **National Engineering Science Co.**, Pasadena, Calif., for research program in advanced areas of missile and space sciences. Specialized research projects which Douglas will assign to NESCO will involve such fields as high-temperature materials, solid-state physics, aerothermochemistry, thin-shell dynamics, fluid dynamics and reaction controls. No amount disclosed.

Lockheed Aircraft Corporation, to work out an automatic timetable system for charting flight paths in space for low-thrust rockets. Amount not disclosed.

NAVY

Developmental Engineering Corporation, Leesburg, Va., has been awarded a Communications Moon Relay System follow-on contract to provide CMR with a single-side band operation with the current CMR frequency-shift keyed system. Amount not disclosed.

$650,000—**Summers Gyroscope Co.**, Santa Monica, Calif., for free gyros to be used in advanced *Terrier* and *Tartar* guided missiles. Subcontract from **Convair/-Pomona, Convair Div. of General Dynamics Corporation.**

$113,500—**Yale University**, New Haven, Conn., for preparation of a catalog of positions of the stars in the Southern Hemisphere.

$44,999—**Convair Division, General Dynamics Corp.**, Pomona, Calif., for technical nonpersonal services of experimental factory personnel, facilities and equipment to design and prepare drawings covering final inspection gages for *Polaris* and *Tartar* missiles.

ARMY

$2,833,884—**Raytheon Manufacturing Co.**, Waltham, Mass., for continuation of work on the *Hawk* missile.

$2,440,879—**Sperry Rand Corp.**, Salt Lake City, for engineering services, ground handling and test equipment for *Sergeant* guided missile system; two contracts.

$1,740,000—**Pan American World Airways, Inc.**, New York City, services and material for planning, development design, installation, operation, maintenance, and modernization of Electronic Environmental Test Facility at Electronic Proving Ground, Ft. Huachuca, Ariz.

$1,700,000—**Beech Aircraft Corp.**, Wichita, Kan., for production of an additional quantity of Beechcraft *Model 1025* missile targets.

$313,953—**Lear, Inc.**, Santa Monica, Calif., for research and development of gyroscopes.

$200,000—**Summers Gyroscope Co.**, Santa Monica, two contracts from **Beech Aircraft Corp.**, Wichita, Kan., for position-and-rate gyros and system components for use in surveillance missiles.

$149,259—**Nortronics, Division of Northrop Corp.**, Anaheim, Calif., for *Hawk* missile system spare parts.

$128,986—**Stanford Research Institute**, Menlo Park, Calif., for research and development work leading to establishment of design for microwave filters and coupling structures.

$99,506—**Federal Systems, Division of International Business Machines, Inc.**, Kingston, N.Y., for research work in the field of "thin-film circuit functions" and periodical technical reports relative thereto.

$79,668—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for research and development in design and development of remote setting microbaroswitch.

$75,000—**Stanford University**, Stanford, Calif., for continuation of R&D work to investigate "Solid-State Two-Level High-Power Maser."

$64,379—**RCA Laboratories**, Princeton, N.J., for research and development in the study of low-noise electron beams.

$33,783—**Advanced Technology Corporation**, Goleta, Calif., for study of gun-boosted rocket systems.

$31,402—**Gilfillan Brothers, Inc.**, Los Angeles, for *Corporal* missile system repair parts.

The Keystone Electronics Co., Newark, N.J., awarded several contracts by **Raytheon Manufacturing Co.** for development of filters on the *Mauler* program. Amount not disclosed.

AIR FORCE

Hamilton-Standard Division of United Aircraft Corp., Windsor Locks, Conn., two contracts from **The Martin Company** for ground support equipment for use in the development of the *Titan* II ICBM. No amount disclosed.

$3,000,000—**North American Aviation's Los Angeles Division**, to modify F-100 Super Sabres to carry and launch *Bullpup* air-to-surface missiles.

$1,500,000—**North American Aviation's Space and Information Systems Division**, Downey, Calif., for study of ways to provide environments required by man and his equipment in space. Program is entitled "The Space Vehicle Thermal and Atmospheric Control Study" and is expected to last 3 years.

$1,250,000—**Aerojet-General Corporation**, Azusa, Calif., for construction of a facility to test and manufacture infrared subsystems for the *Midas* satellite.

$566,126—**Convair Div., General Dynamics Corp.**, Pomona, Calif., for a high-temperature, nuclear radiation-resistant pneumatic system for operating the flight control surfaces of supersonic aircraft or missiles.

$361,459—**AVCO Corporation (Everett Research Laboratory)**, Everett, Mass., for research on "Plasma Propulsion."

$278,148—**Texas Instruments, Inc.**, Dallas, for PCM telemetry recording system.

$257,543—**G. W. Galloway Co.**, Baldwin Park, Calif., for construction of a liquid-solid propellant test facility at Test Site #1, Edwards AFB, Calif.

$196,374—**General Precision, Inc., Kearfott Div.**, for gas-bearing gyros for space missions.

$100,000—**University of Illinois**, Urbana, for research into the basic properties of gaseous plasmas.

$60,800—**Radio Corporation of America**, Camden, N.J., for investigation of transportable search radar and IFF beacon.

$54,804—**Lockheed Aircraft Corporation (Missile Systems Division)**, Sunnyvale, Calif., for continuation of research on the theory of composite propellant burning.

$50,000—**University of California**, Berkeley, for continuation of research on "High Precision Geocentric and Interplanetary Orbits."

$50,000—**RIAS Division**, Baltimore, for research on "Properties of Conduction Electrons in Ionic Crystals.

$41,912—**Thiokol Chemical Corporation, Reaction Motors Division**, Denville, N.J., for rocket exhaust sampling system for two-phase flow systems.

$40,000—**Raytheon Company, Research Division**, Waltham, Mass., for investigation of effects of ion-induced defects on surface reactions.

$38,537—**Texaco Experiment, Inc.**, Richmond, Va., for continuation of research on "Properties of Ion in Flames."

letters

Carriers and Space

To the Editor:

Permit me to be the first to accept your invitation (Editorial, M/R, Feb. 20, p. 50) by suggesting that manned spaceships can and *should* be launched and recovered at sea from modern "carriers."

Please feel free "to burn this letter" as you will not be the first—suggestions for launching propeller aircraft, jet aircraft, missiles and rockets at sea were also originally burned.

John D. Nicolaides
Technical Director for Astronautics
Bureau of Naval Weapons
Department of the Navy
Washington, D.C.

First letter was burned; this is the second.—Ed.

Meteorites No Hazard

To the Editor:

The general use of the term, "meteorite," for particles orbiting in outer space prompts me to point out that according to Noah Webster there are no meteorites in outer space!

Our technical reports and magazines as well as newspapers persist almost unanimously in referring to the particles as meteorites and micrometeorites. Many Space-Age writers are apparently following the wrong path taken by pioneers in this relatively new field when a look in the dictionary could quickly set them straight.

The definition of a meteorite is, "a stony or metallic body which has fallen to earth from outer space," and a meteoroid is defined as, "one of the countless small solid bodies in the solar system, which become meteors on entering the earth's atmosphere." Therefore, we have meteoroids in outer space, which burn as visible meteors when they enter the earth's atmosphere and finally become meteorites only if they survive their fiery journey and fall to the earth's surface. Thus, the meteorite is the cinder of a partially burned meteoroid to be found on the earth.

In our museums we can see meteorites, which have been picked up from the ground, and someday we may be able to see meteoroids which have been picked up from space. However, since it is highly unlikely that any meteorites will ever be encountered in outer space, let's equip our satellites with micrometeoroid detectors and our space ships with protection against meteoroid impact and leave the meteorites in the museum where they belong.

Richard B. Hoag
Member of the Technical Staff
Space Technology Laboratories, Inc.
Los Angeles

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—when and where—

MARCH

Eleventh Annual Instrument Society of America Conference, Roosevelt Hotel, Pittsburgh, Mar. 8-10.

Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, sponsored by IRE, AIEE, IAS, University Museum, Philadelphia, Mar. 9-10.

Institute of the Aeronautical Sciences, Flight Propulsion Meeting, (classified) Cleveland, Mar. 9-10.

American Society of Mechanical Engineers, Aviation Conference, Statler-Hilton Hotel, Los Angeles, Mar. 12-16.

American Rocket Society, Test Operations and Support Conference, Biltmore Hotel, Los Angeles, Mar. 13-16.

1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

Inter-Station Supersonic Track Conference, (confidential), Sixth Supersonic Track Symposium, U.S. Naval Ordnance Test Station, China Lake, Calif., Mar. 14-16.

Fifth National Conference on Aviation/-Space Education, Mayflower Hotel, Washington, D.C., Mar. 16-18.

American Astronautical Society Symposium, Interactions of Space Vehicles with an Ionized Atmosphere, cosponsored with AFOSR and ARPA, Sheraton Park Hotel, Washington, D.C., Mar. 17.

Radar Transmitter FPS-35

For the security of our nation

The AN/FPS-35 Radar Search Set is an integral part of America's security defense network. This massive sentinel stands in vital areas protecting the nation.

FXR is the designer and developer of the Line Modulator, the key block in the transmitter complex. High level engineering combined with complete precision facilities produced the answers to the unique problems encountered.

Solutions to the most exacting specifications are the foundation of FXR's service in High Power Electronics. The solution to your particular problem is but a phone call away. Just call and ask for an FXR applications engineer to discuss your needs.

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editorial . . .

Let's Not Hang an Untried Man

ONE OF THE toughest jobs in the Kennedy Administration is that held by the new chief of the National Aeronautics and Space Administration, James E. Webb.

Not only does he head an agency whose success or failure will reflect globally on the prestige of the President and of the nation, but he has inherited a number of vexing internal problems.

No one is more aware of this than Mr. Webb.

A weekly aviation publication has termed Mr. Webb's appointment a great disappointment. We do not agree. Nor do we know yet if we will disagree.

What we do say is this: James E. Webb deserves a fair chance to tackle the important job he has accepted without being labeled a failure before he starts.

President Kennedy was well aware at the time he selected Mr. Webb that his new NASA chief was not a scientist. Mr. Webb was one of those who made this point to the President most emphatically. But what the President wanted was a good administrator, a man with the ability to run a sizeable organization and to help create an effective national space policy.

He has his administrator. Whether he has a good one remains to be seen.

But we are inclined to go along with President Kennedy's belief that it does not necessarily take a scientist to run a scientific organization. Other abilities, not frequently found in a first-rate scientist, may be more important.

Mr. Webb has had more than a dilettante's interest in science. While Under Secretary of State, he introduced the practice of assigning science attaches to major embassies, a long overdue recognition of the importance of science in the conduct of our national affairs. He also has been very active in a program to improve high school physics courses, certainly a foundation-stone of our national scientific well-being.

Mr. Webb is aware that there is a strong feeling against his appointment inside some scientific quarters of NASA itself. He is hopeful of overcoming this.

He told a visitor to his office last week he does not feel his job is to tell NASA's scientific staff in detail what to do, but to create an atmosphere of creativity in which scientific work and innovation can flourish. If he succeeds in doing that, he will have gone far toward healing any breach. His awareness of the problem is a big step in the right direction.

Mr. Webb also is aware of the potential dangers of the conflict between NASA and the Air Force for scarce space dollars. To say that this has at times verged on bitterness would be understating it.

Mr. Webb has met the problem head-on by discussing it with the senior military officers involved.

"I am sure we will have the closest cooperation among the senior officers of all the departments concerned with space activities in the interest of an effective national program," he says. He has both given and received assurances of that.

THIS DOES NOT mean the NASA chief expects all competitive feeling between NASA and the Air Force to disappear at more junior levels. He regards this as natural, and not necessarily undesirable.

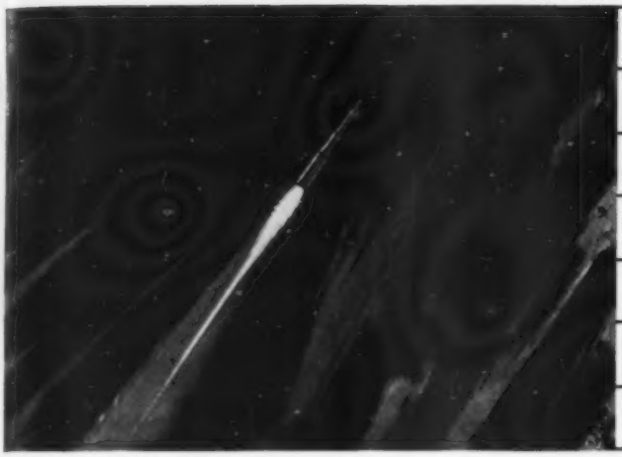
Nor did Mr. Webb accept his post to preside over the dismantling of NASA in favor of a rapidly expanding Air Force space capability. There is a need and room for both.

The new administrator is engaged with his staff in a thorough review of the agency's Ten-Year Program for space, similar to the military reviews delivered to the President by Defense Secretary McNamara. In this period, Mr. Webb has kept his door open to industry. Several company presidents who have telephoned for an appointment have been told: "Come on over right now." We will watch with interest the program which emerges.

We will be among the first to criticize Mr. Webb if we feel he has made a mistake. Meanwhile, we will withhold judgment.

Let's not hang a man before he commits a crime.

William J. Coughlin



A SECOND SHOT HEARD ROUND THE WORLD:

On February 1st, a new American missile roared upward from its pad at Cape Canaveral. It was the Air Force Minuteman. It was the first flight of a three-stage intercontinental ballistic missile. It was a success.

The 20th Century Minuteman

The Minuteman ICBM was launched by automatic checkout equipment. It was guided by an extremely advanced electronics device, an operational inertial guidance and control system. A system of similar principle guides America's nuclear-powered Polaris submarines. Both the submarine and missile guidance systems, as well as the Minuteman automatic checkout equipment, were designed and built by Autonetics, a Division of North American Aviation. Today, because of the Twentieth Century Minuteman, the United States is a stronger nation... and peace for the Free World is more secure.

Electromechanical Systems by **Autonetics** Division of North American Aviation

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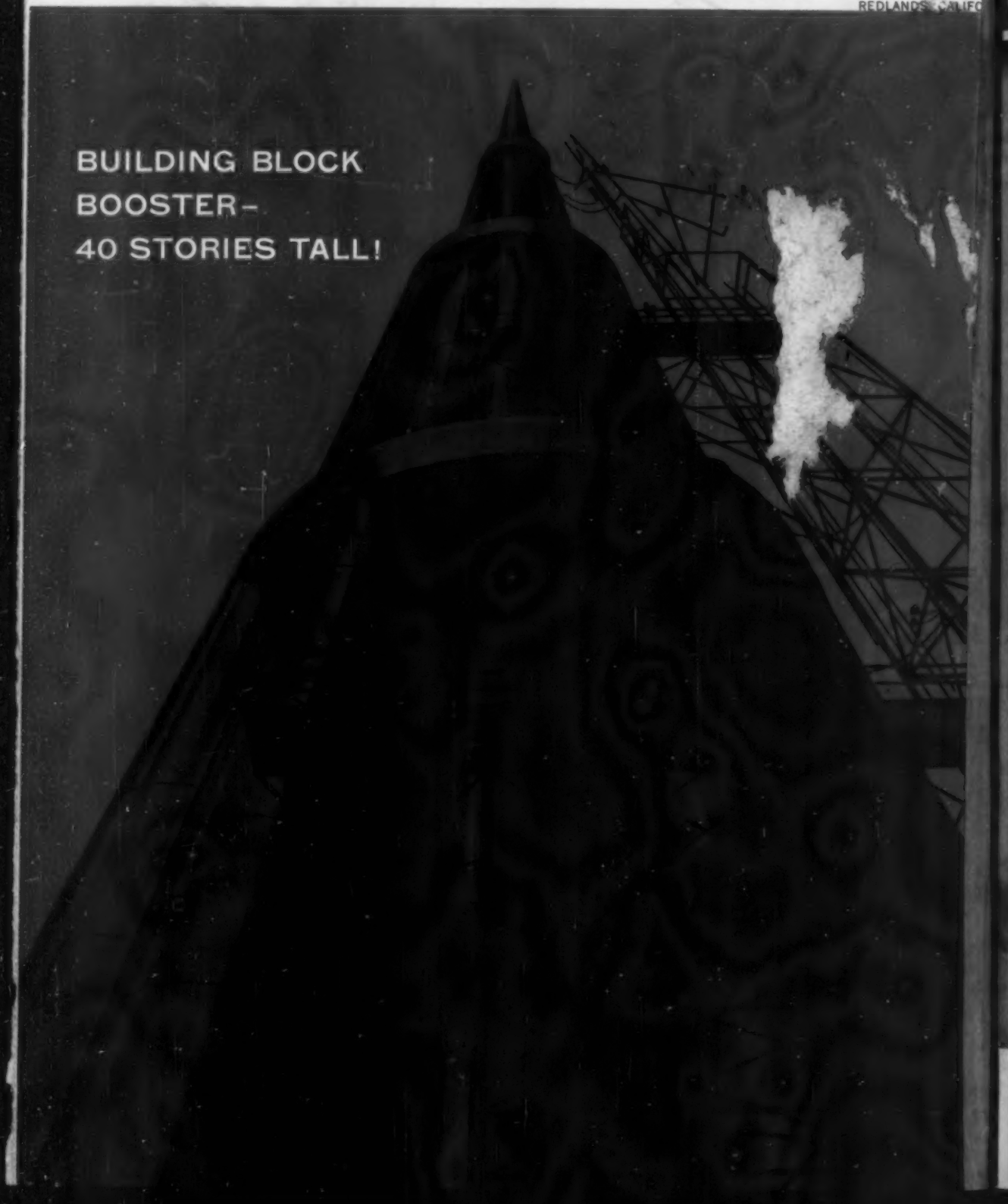
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